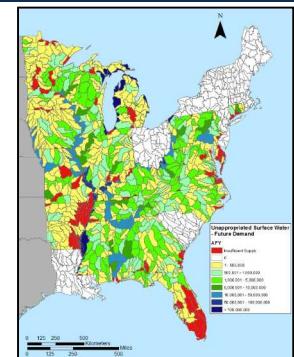
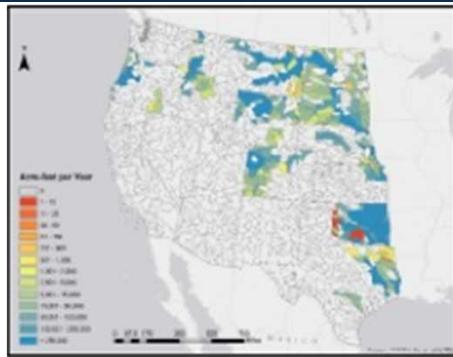
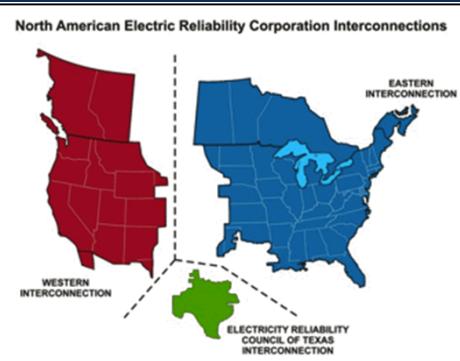


Exceptional service in the national interest

SAND2015-9243C



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)



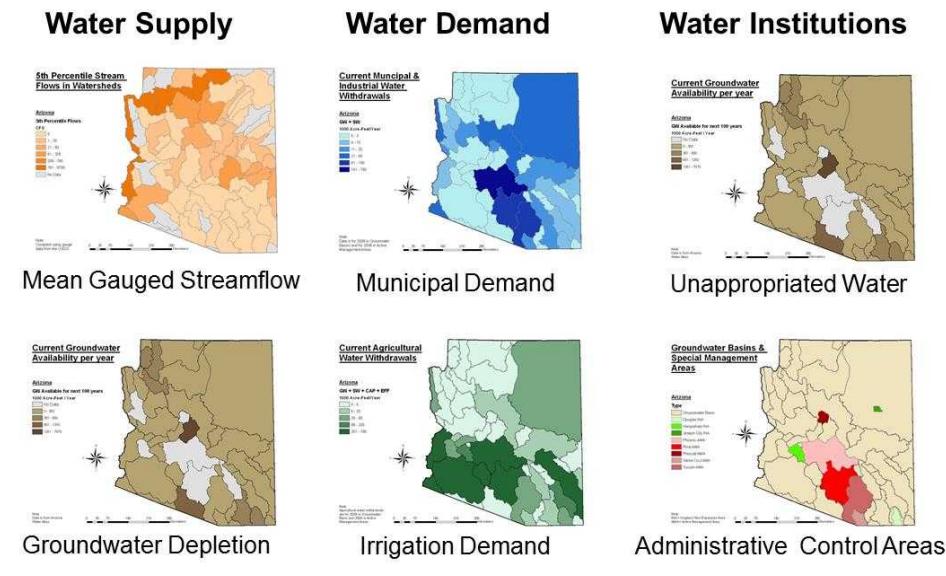
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Technical background/motivation for the project

- 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.

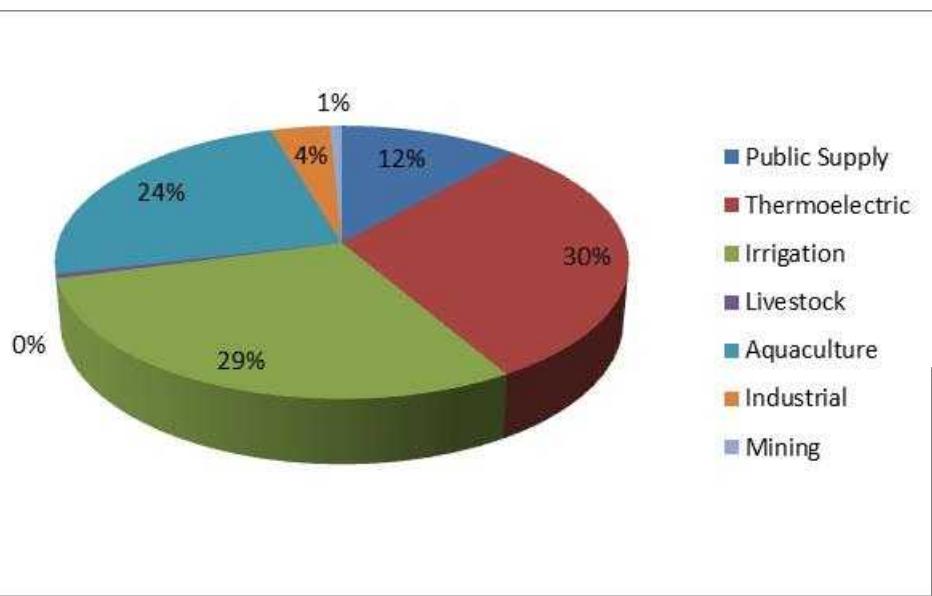


Relevancy to Fossil Energy

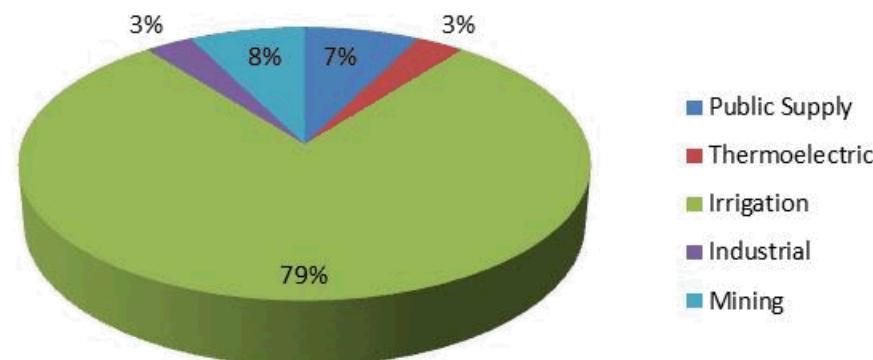
- Water use by electric power plants is becoming an increasingly important issue in the U.S. in view of growing demands for water and increasing stresses on fresh water supplies
- Thermal power plants currently account for nearly 30 percent of all freshwater withdrawals in the U.S. (roughly equivalent to agriculture).
 - Water is used primarily for cooling and secondarily for operating environmental control systems such as sulfur dioxide control .
 - CO₂ 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

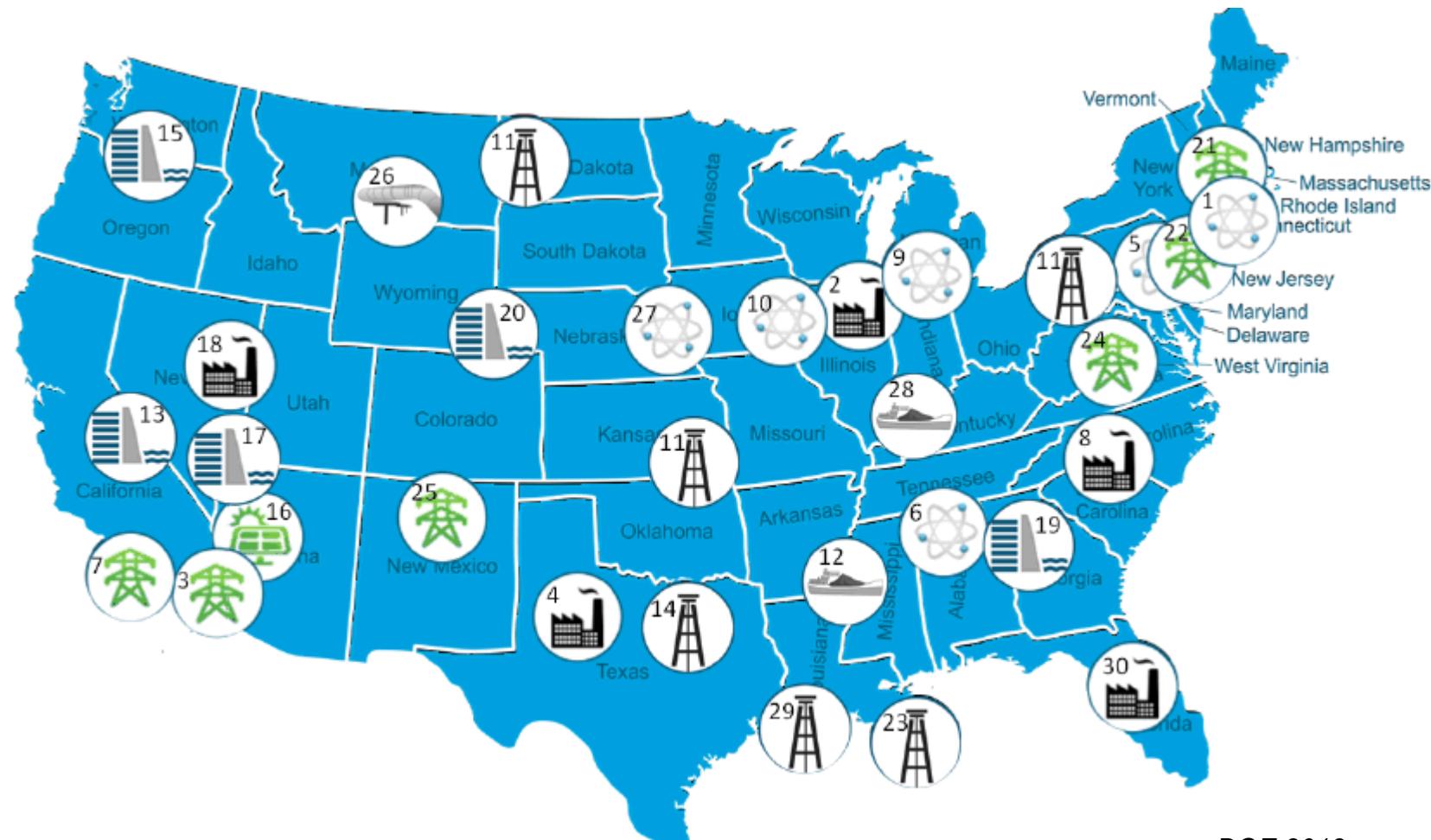
Water Withdrawal (306 BGD) 2010



Water Consumption (106 BGD) 1995



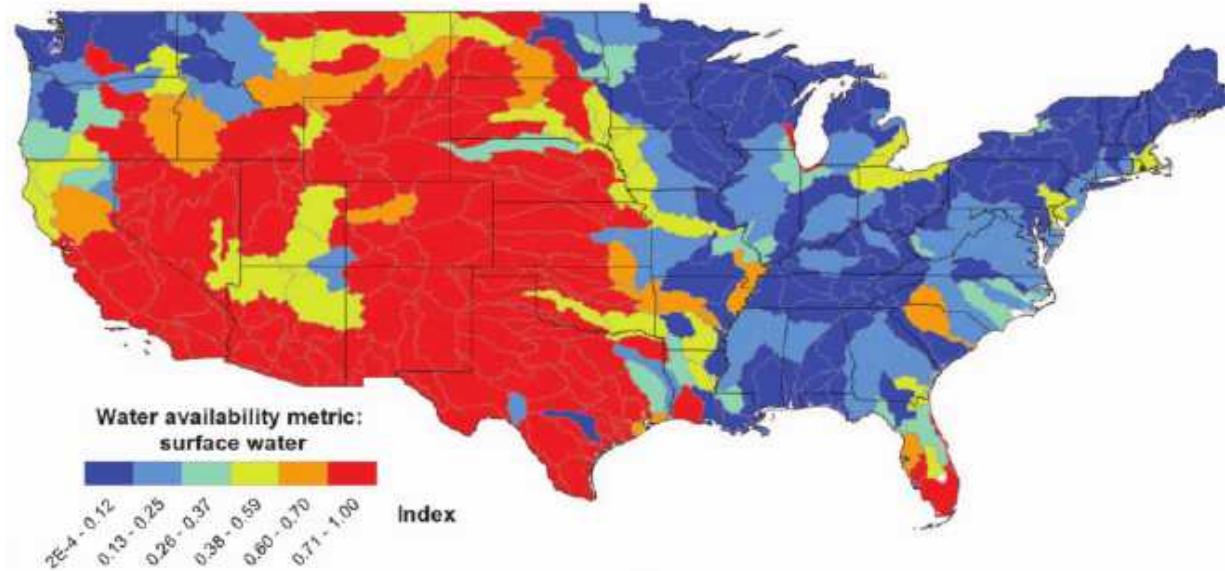
Relevancy to Fossil Energy



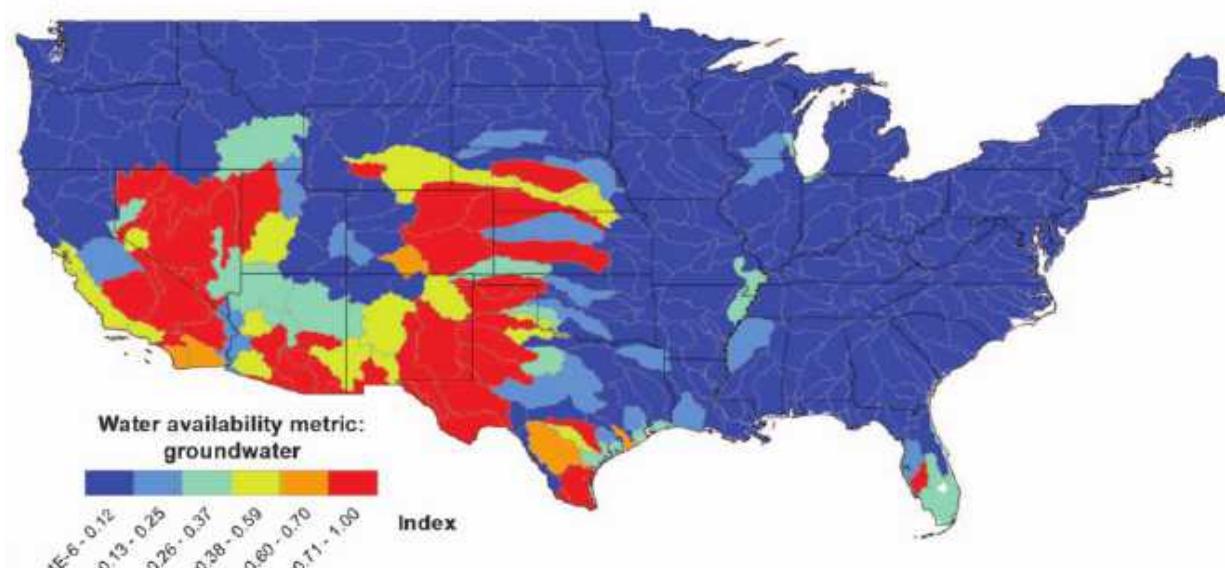
DOE 2013

Relevancy to Fossil Energy

Surface Water Availability

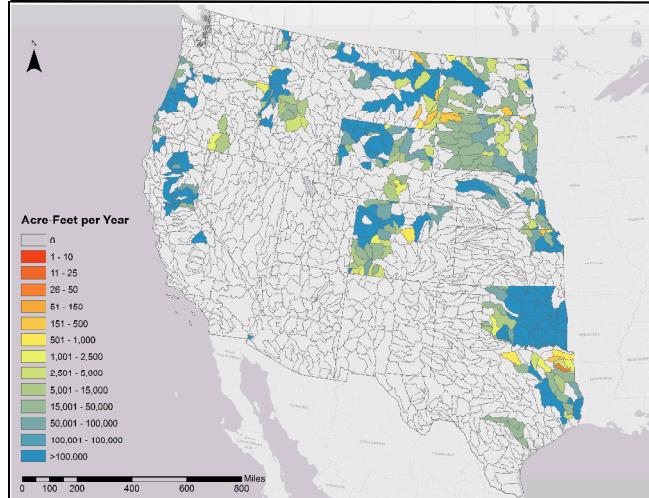


Groundwater Availability

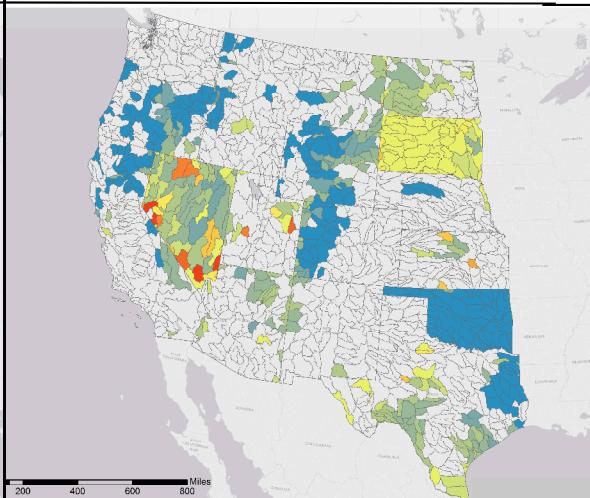


Example: Water Availability in West

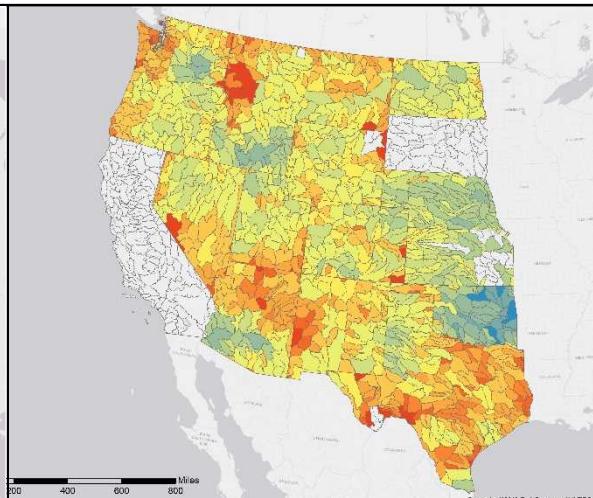
Unappropriated Surface Water



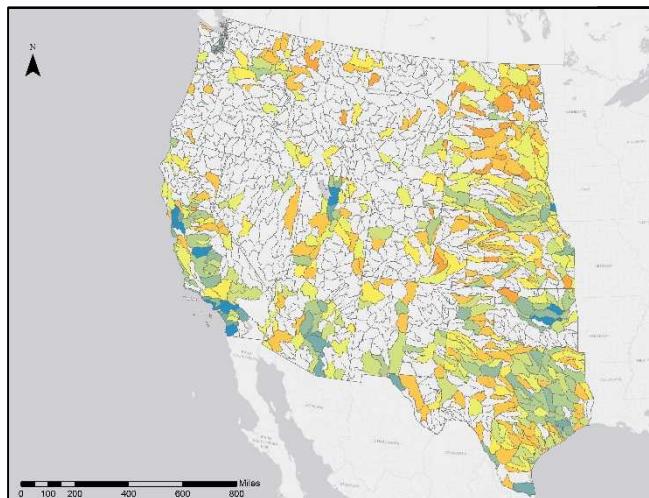
Unappropriated Groundwater



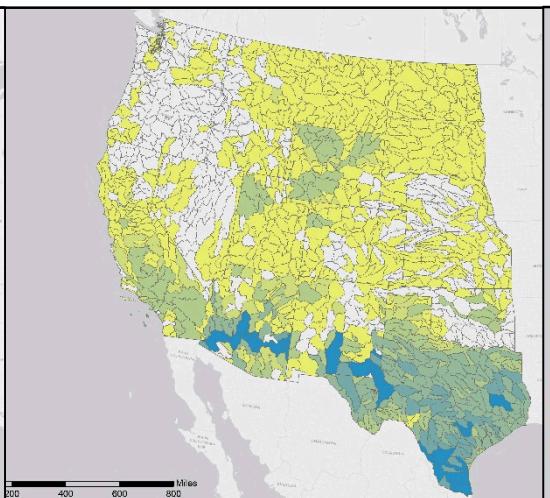
Appropriated Water



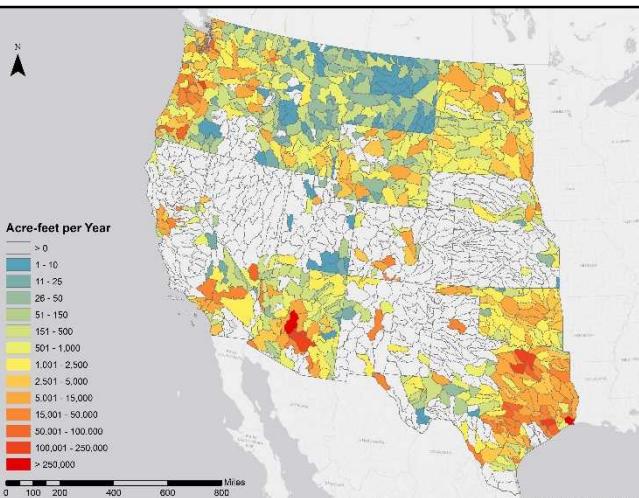
Municipal Wastewater



Brackish Groundwater

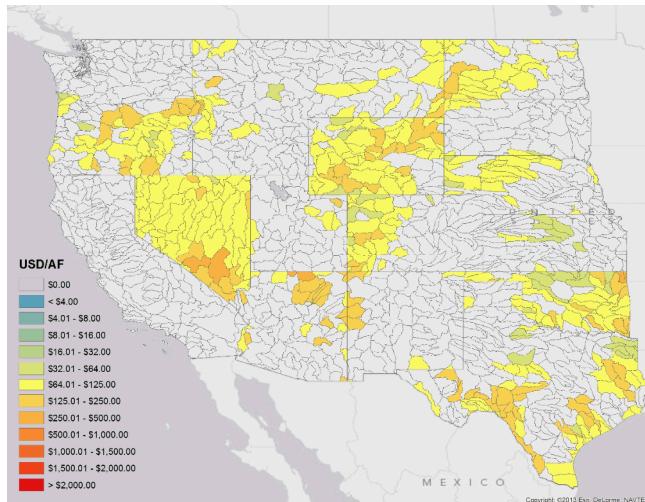


Consumptive Demand 2010-2030

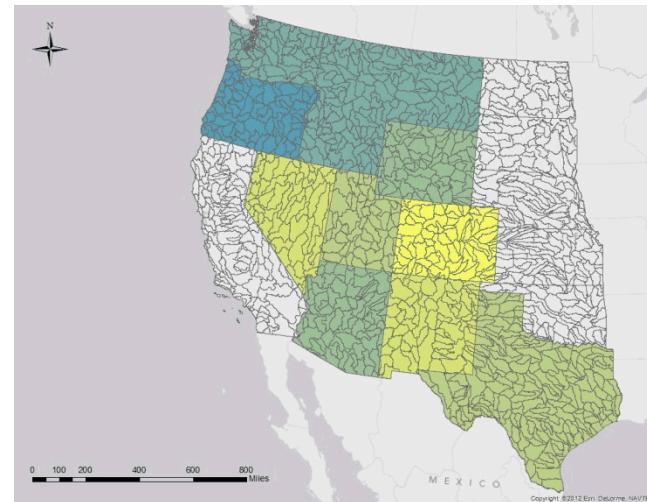


Example: Relative Cost of Water

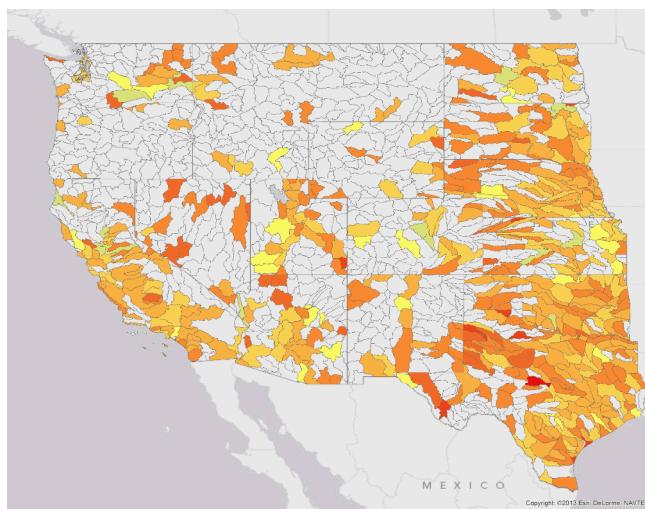
Unappropriated Groundwater



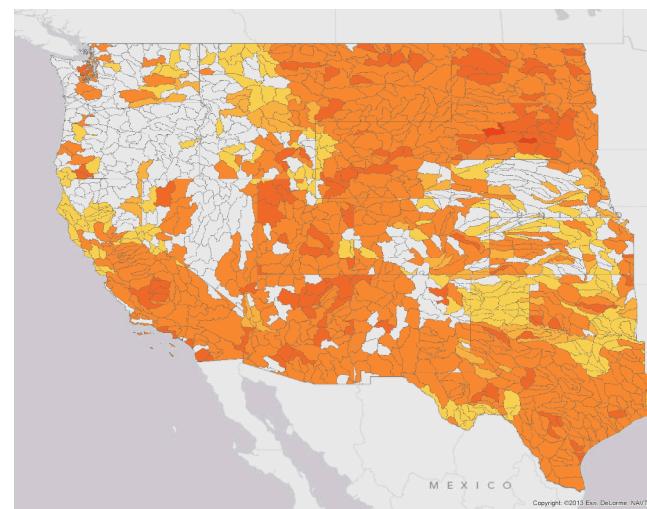
Appropriated Water



Municipal Wastewater



Brackish Groundwater

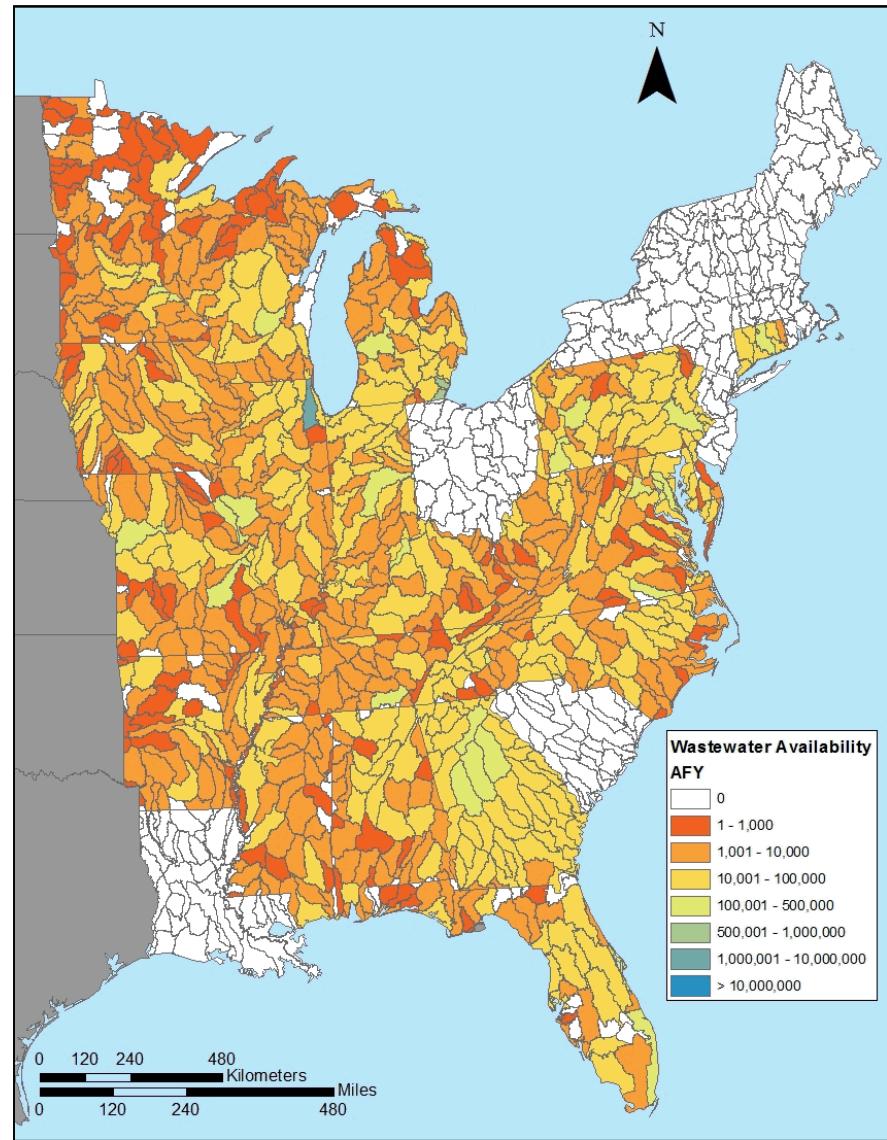
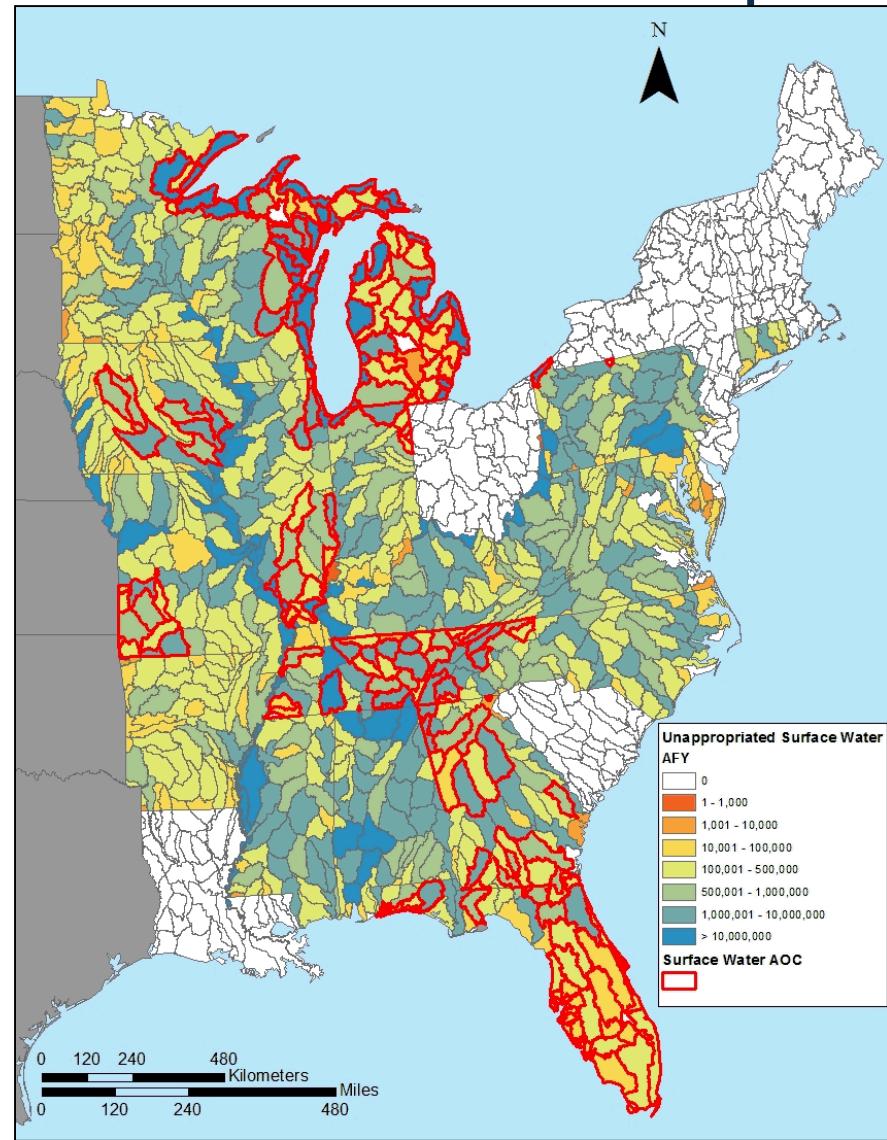


Current Research: Eastern States Water Atlas

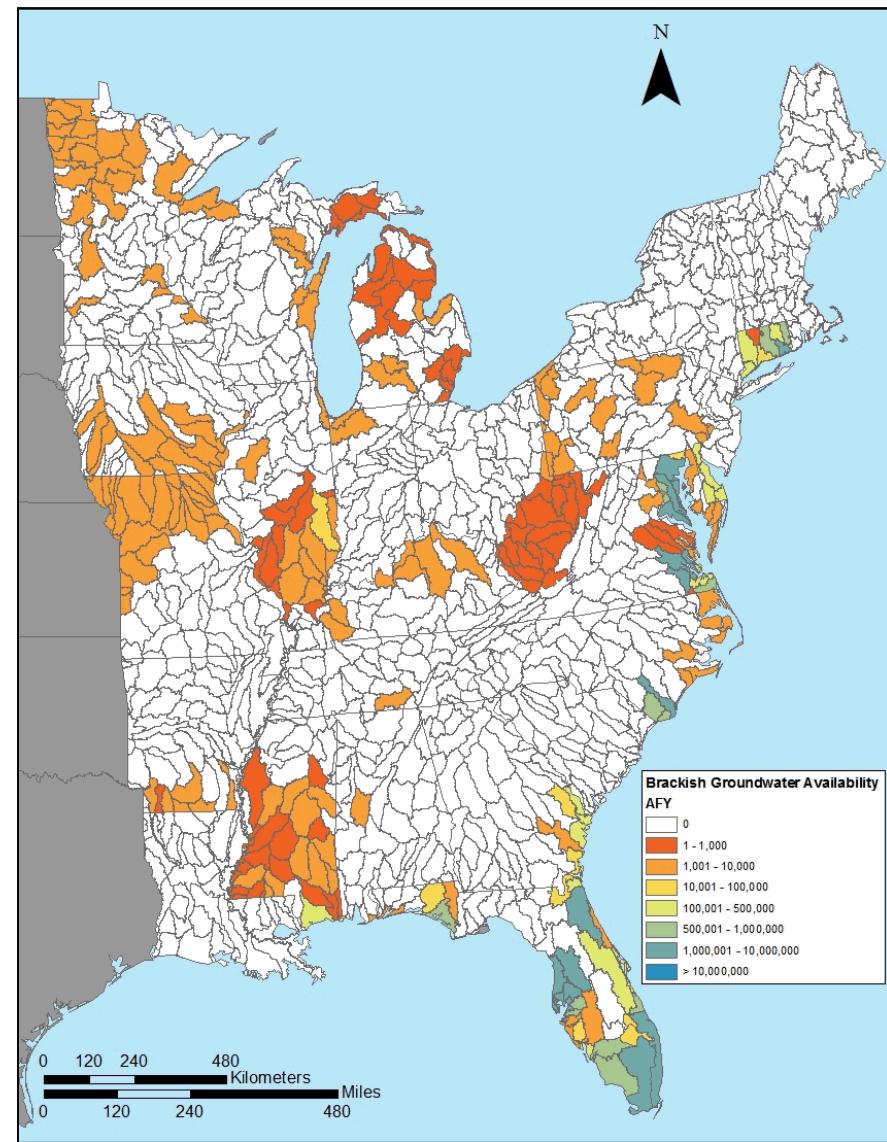
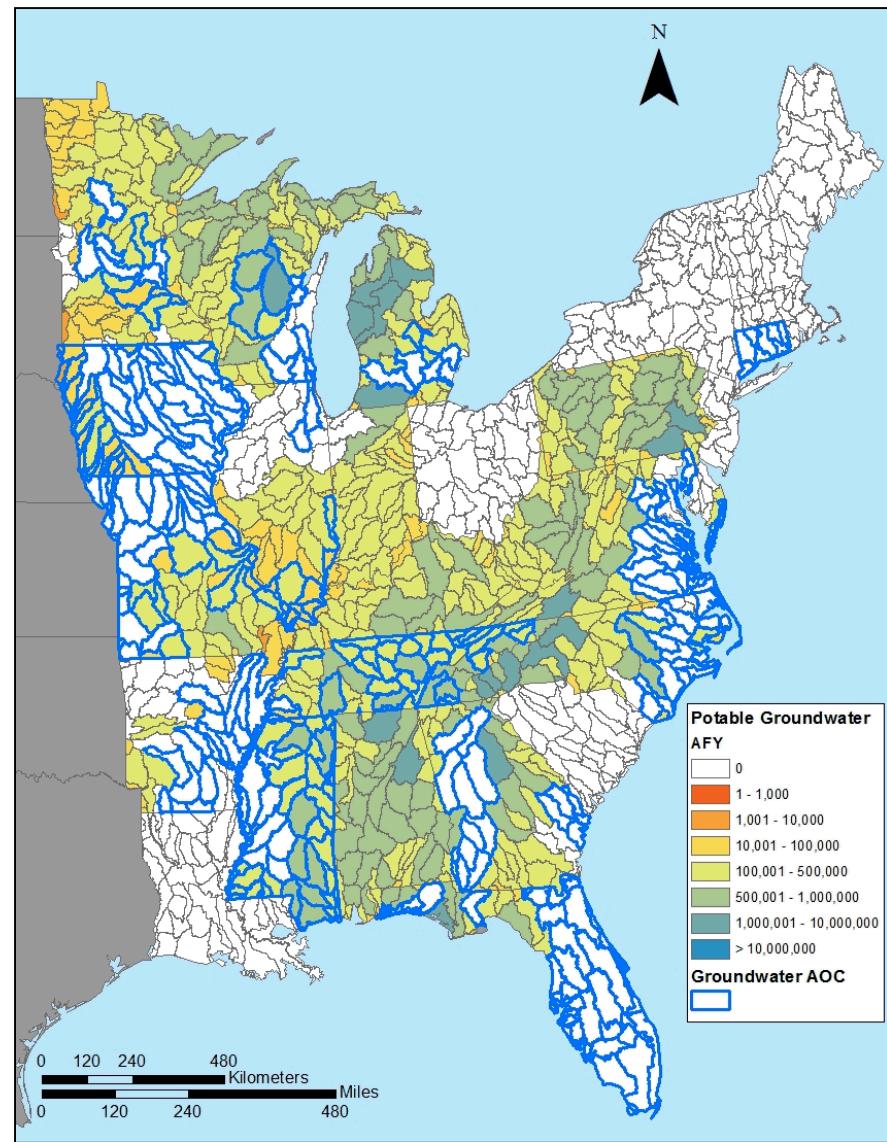


- The objective of the proposed work is to develop both data and models to help better understand the linkage between thermoelectric power generation and water.
- This effort will involve two broad areas of research
 - Development of a Water Atlas (Sandia National Laboratories)
 - Develop water use requirement 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

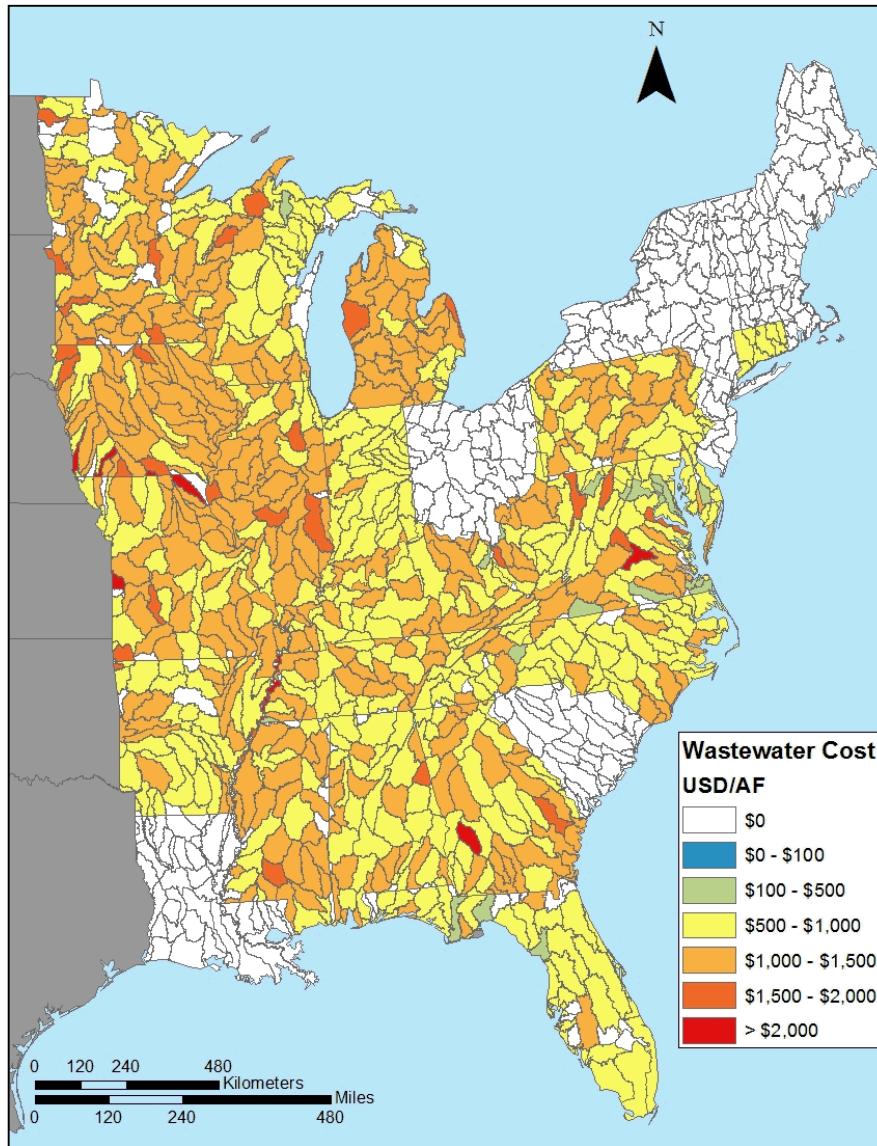
Water Availability: Unappropriated Surface Water and Municipal Wastewater



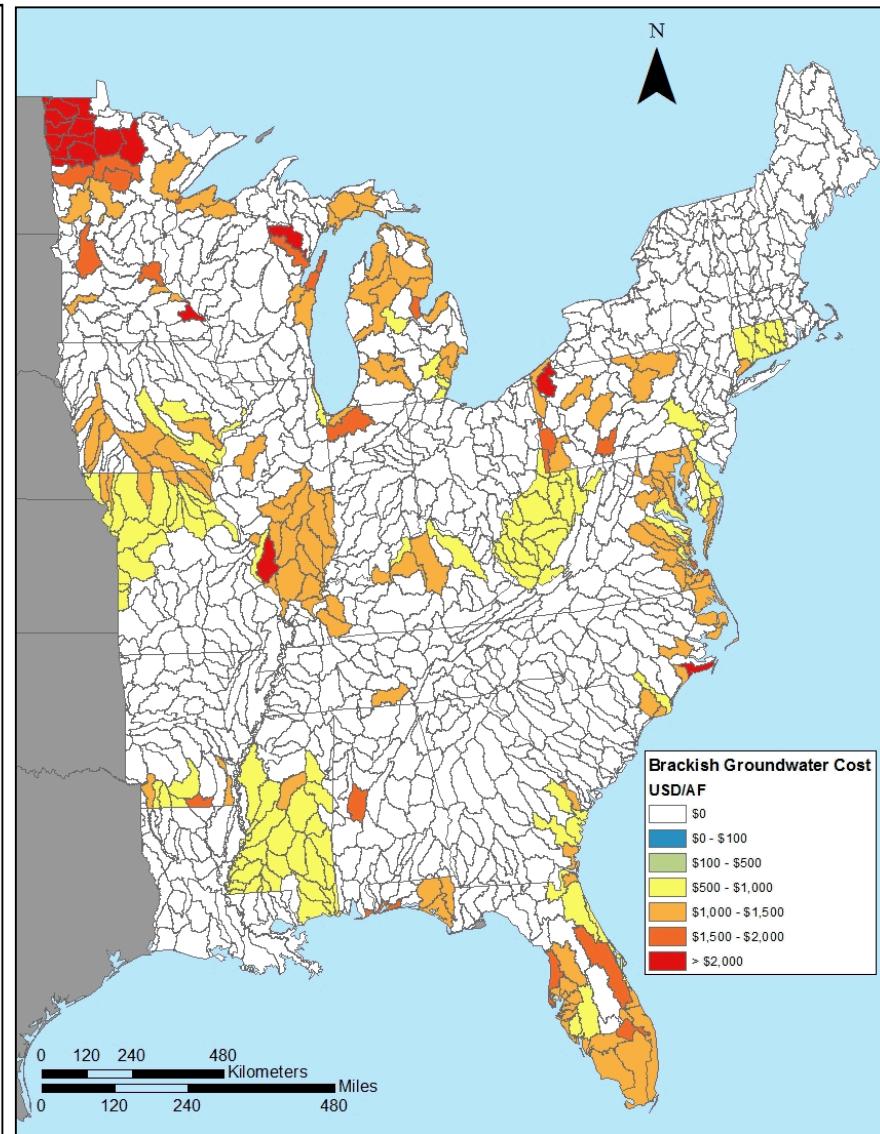
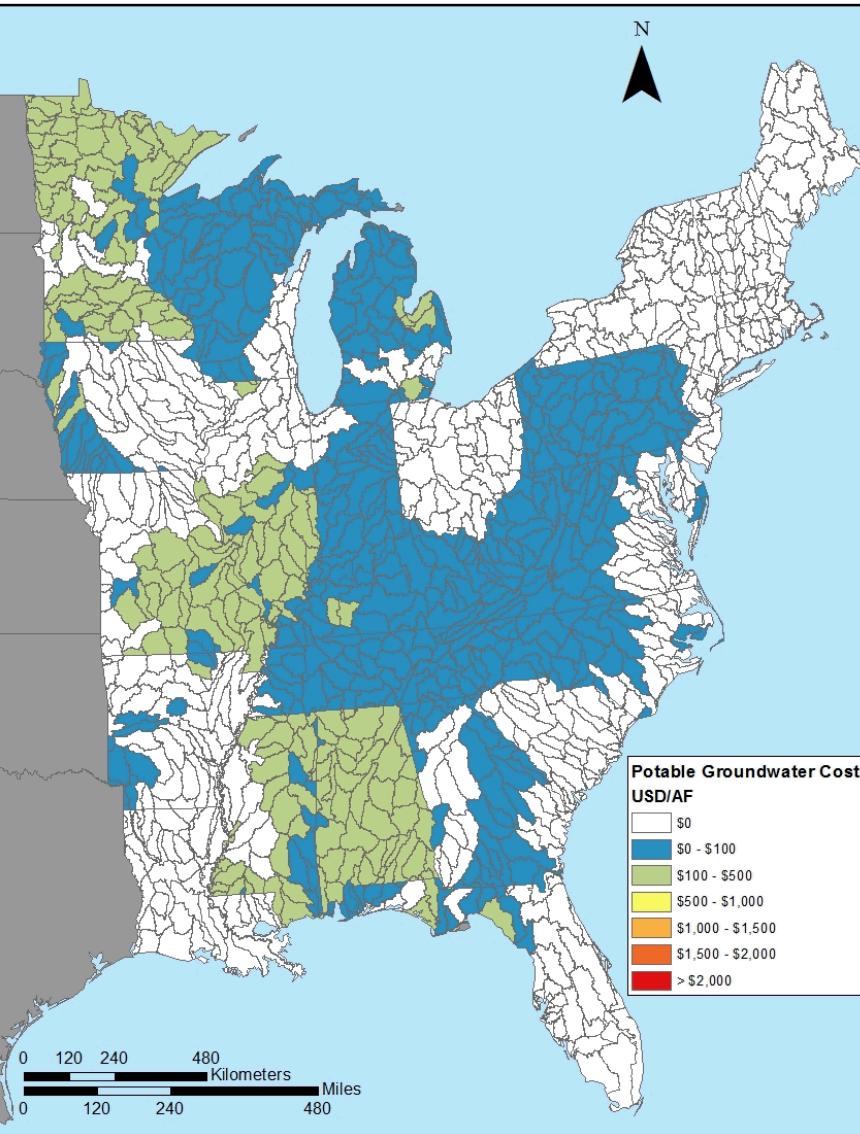
Water Availability: Potable and Brackish Groundwater



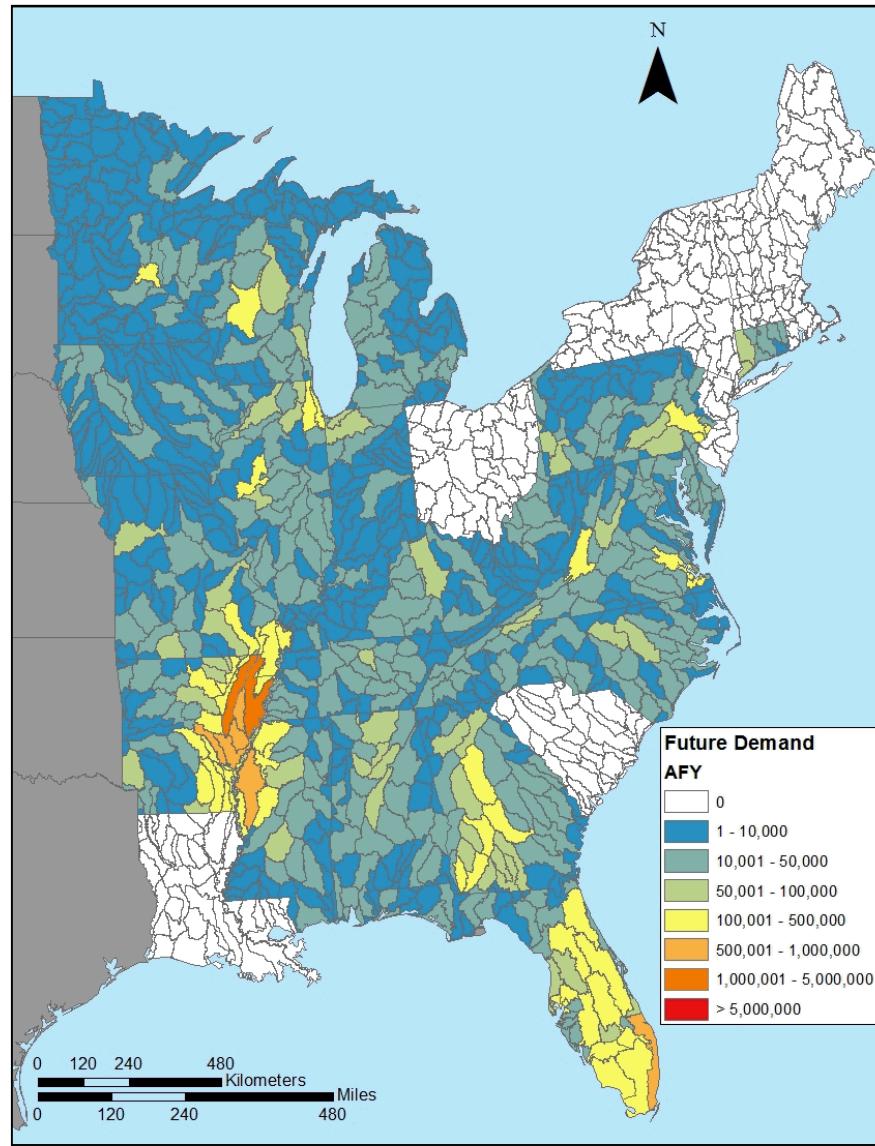
Relative Cost of Water: Municipal Wastewater



Relative Cost of Water: Potable and Brackish Groundwater

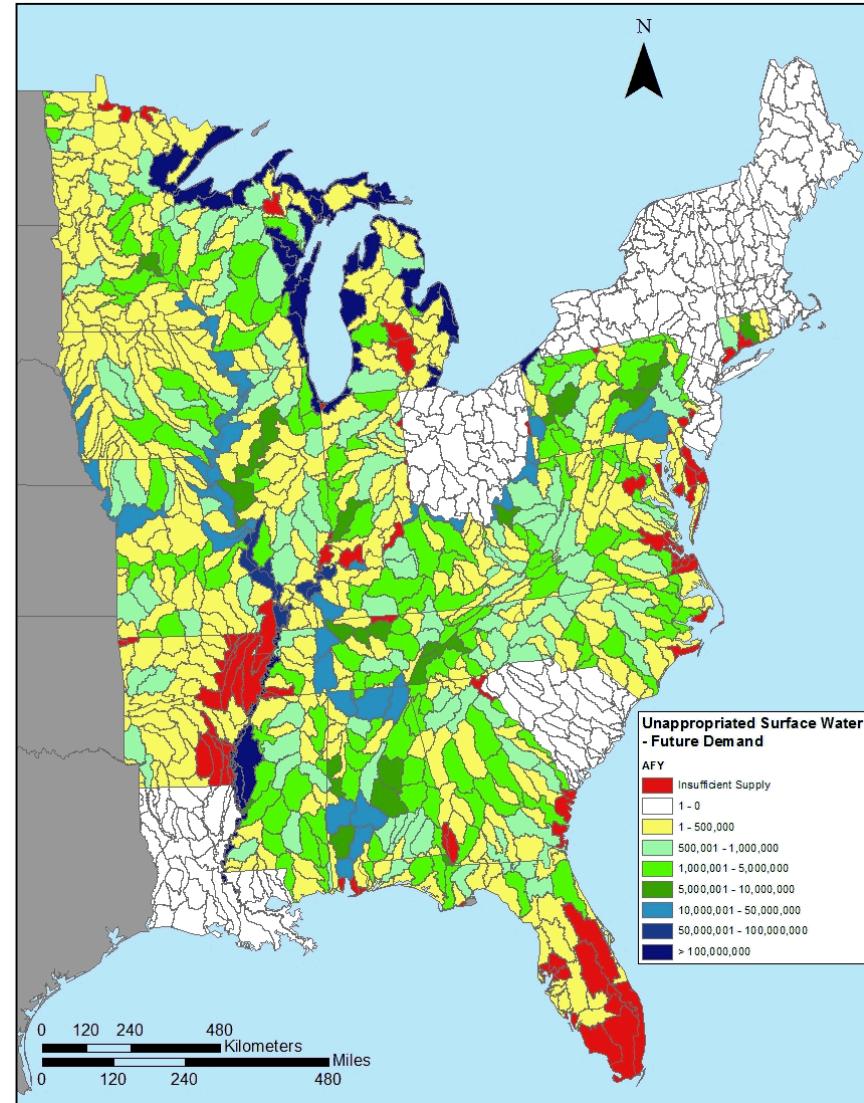


Future Water Demand

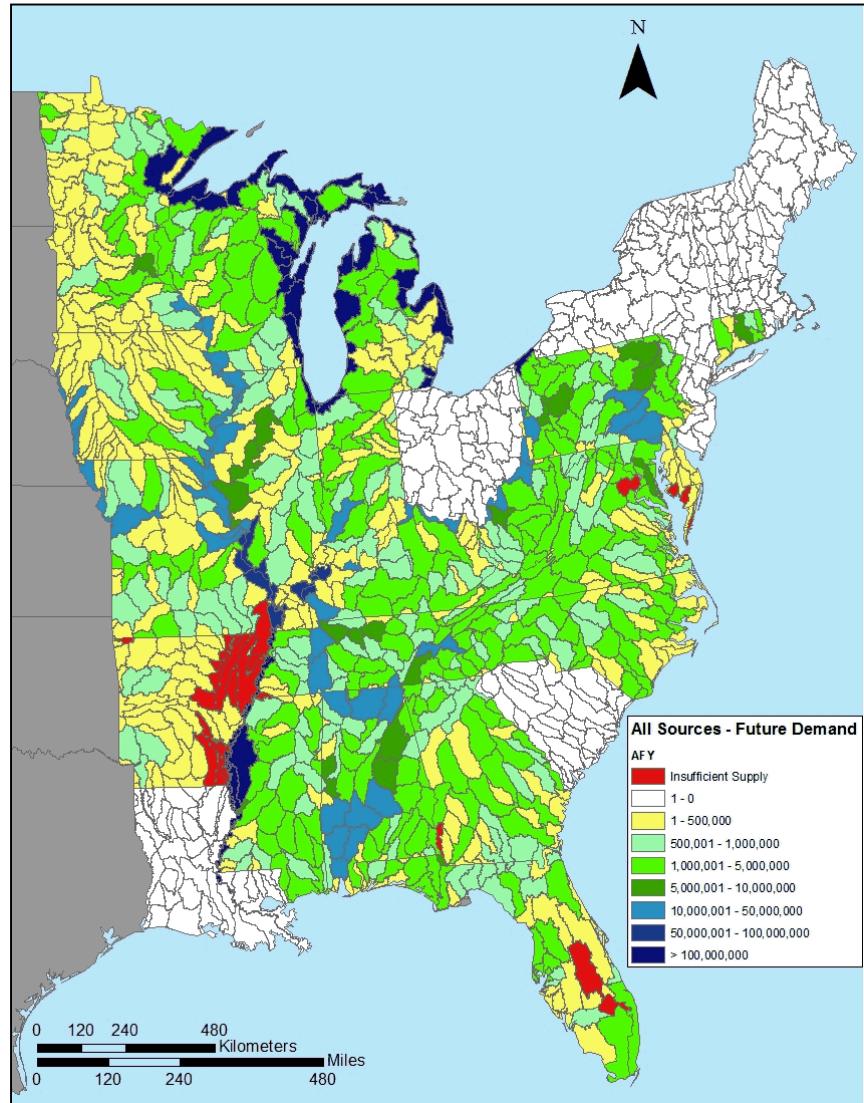


Shortage or Surplus of Surface Water

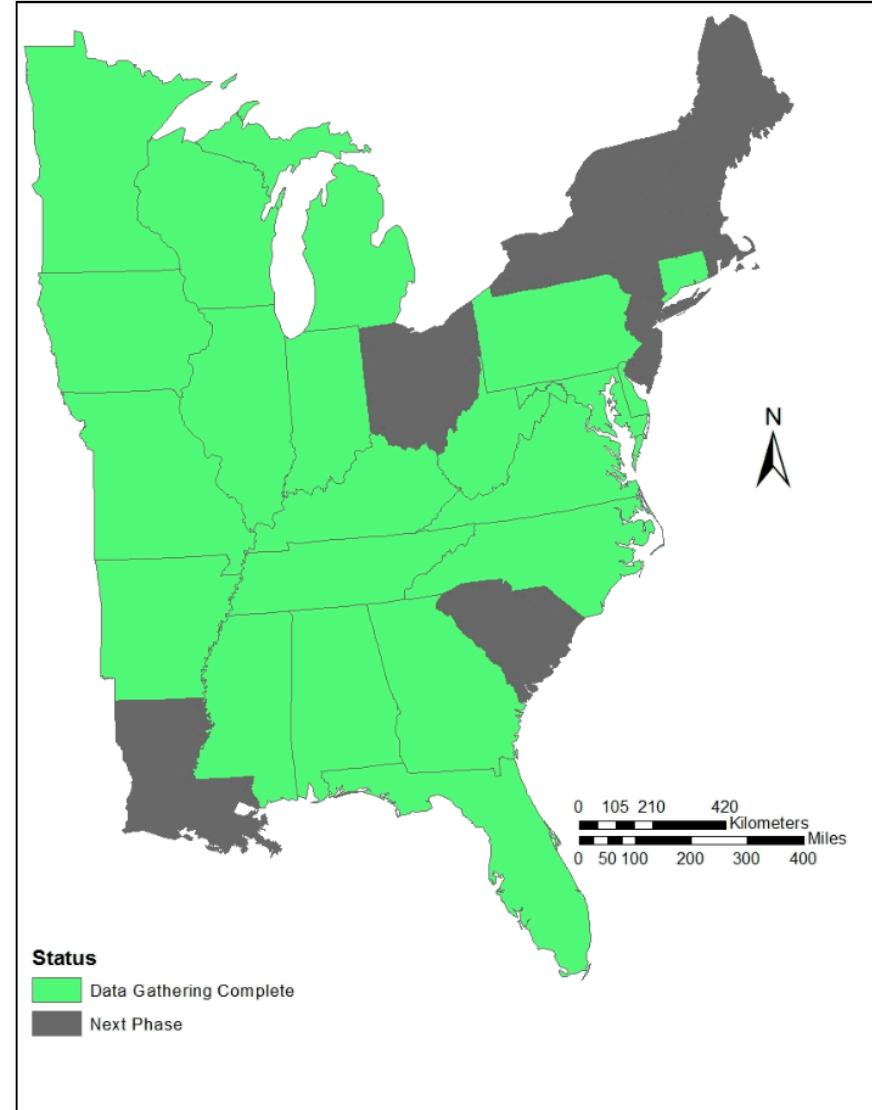
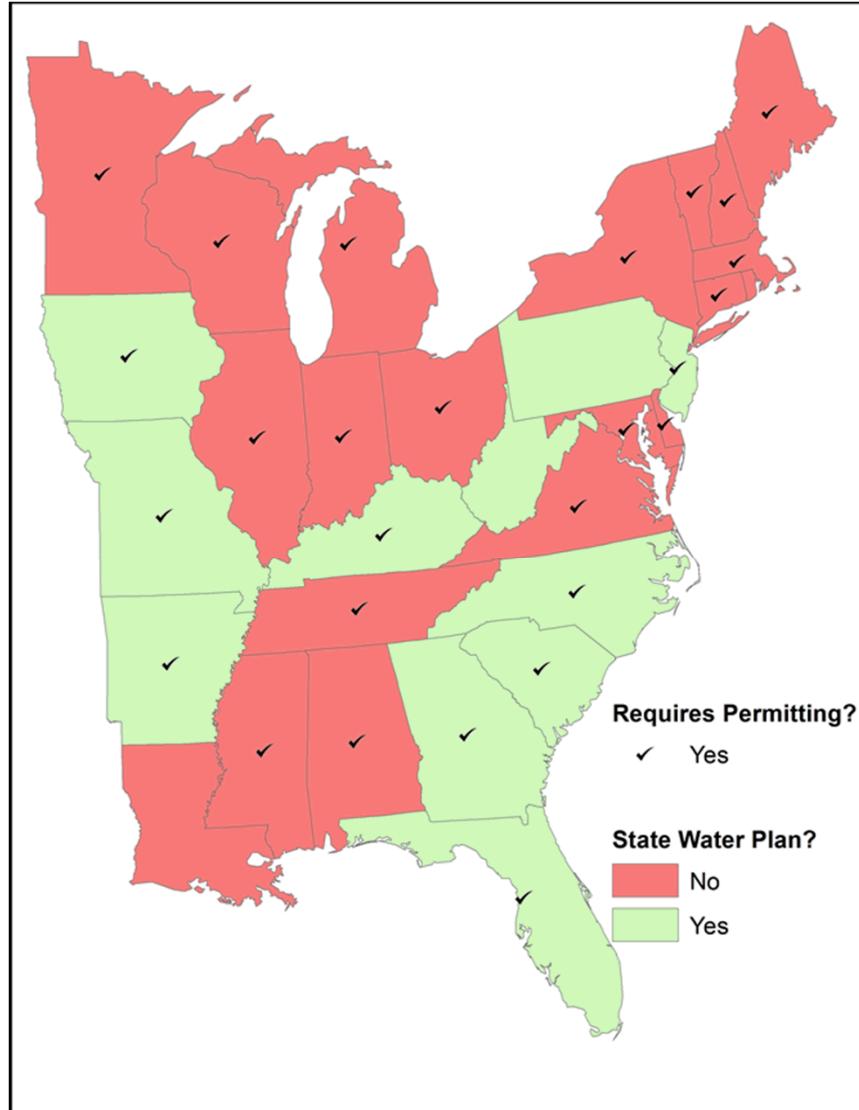
Unappropriated Surface Water – Future Demand



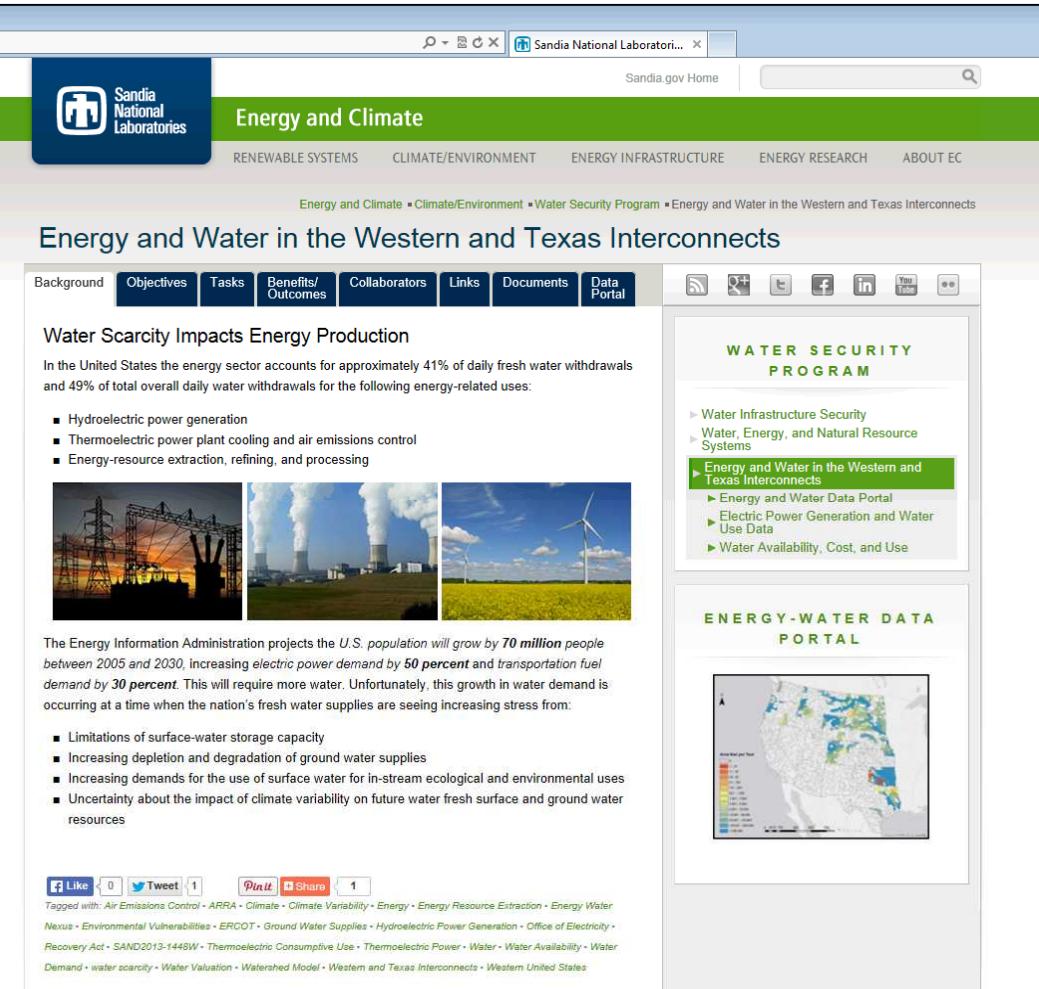
Total Water – Future Demand



Project status: States Requiring Permitting & Data Gathering



Project Status: Data Portal



Energy and Climate

RENEWABLE SYSTEMS CLIMATE/ENVIRONMENT ENERGY INFRASTRUCTURE ENERGY RESEARCH ABOUT EC

Energy and Climate • Climate/Environment • Water Security Program • Energy and Water in the Western and Texas Interconnects

Energy and Water in the Western and Texas Interconnects

Water Scarcity Impacts Energy Production

In the United States the energy sector accounts for approximately 41% of daily fresh water withdrawals and 49% of total overall daily water withdrawals for the following energy-related uses:

- Hydroelectric power generation
- Thermoelectric power plant cooling and air emissions control
- Energy-resource extraction, refining, and processing



The Energy Information Administration projects the U.S. population will grow by **70 million** people between 2005 and 2030, increasing electric power demand by **50 percent** and transportation fuel demand by **30 percent**. This will require more water. Unfortunately, this growth in water demand is occurring at a time when the nation's fresh water supplies are seeing increasing stress from:

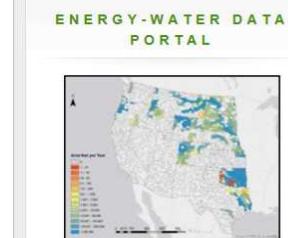
- Limitations of surface-water storage capacity
- Increasing depletion and degradation of ground water supplies
- Increasing demands for the use of surface water for in-stream ecological and environmental uses
- Uncertainty about the impact of climate variability on future water fresh surface and ground water resources

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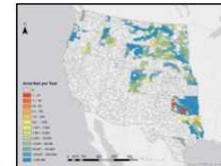


WATER SECURITY PROGRAM

- Water Infrastructure Security
- Water, Energy, and Natural Resource Systems
- Energy and Water in the Western and Texas Interconnects
 - Energy and Water Data Portal
 - Electric Power Generation and Water Use Data
 - Water Availability, Cost, and Use



ENERGY-WATER DATA PORTAL



EISPC EZ Mapping Tool

Help Login Register

EISPC EZ Mapping Tool

A map-based tool for identifying areas within the eastern United States that may be suitable for clean power generation.

About the Tool

The EISPC Energy Zones Mapping Tool is a free online mapping tool to identify potential clean energy resource areas within the Eastern Transmission Interconnection.

This web site provides information [about the study](#), background on the [energy resources](#), and details on the [data layers](#) used in the tool. There are also links to [publications](#) and [regulations](#), [printable maps](#), [documents](#), and [related links](#).

Features

- Nine energy resources: [Biomass](#), [Clean Coal](#), [Geothermal](#), [Natural Gas](#), [Nuclear](#), [Solar](#), [Storage](#), [Water](#), and [Wind](#)
- Flexible analysis of siting factors such as slope and land protections
- Analysis of potential colocation of energy technologies
- Informed analysis to reduce new transmission construction

Getting Started

Click the [Launch Tool](#) button above to start the tool, on the image below to view an introductory [video](#), or use the [Help](#) menu at the top of the page for more detailed directions.

News

November 04, 2014 Updated Models and Modeling Layers All of the suitability models and many of the model layers have been revised to match...

November 04, 2014 Webcast Demonstration: Wednesday November 19 at 2:00 pm Central A one-hour webinar demonstration of the EISPC Energy Zone Mapping Tool will be presented...

October 22, 2014

Partners and Sponsors

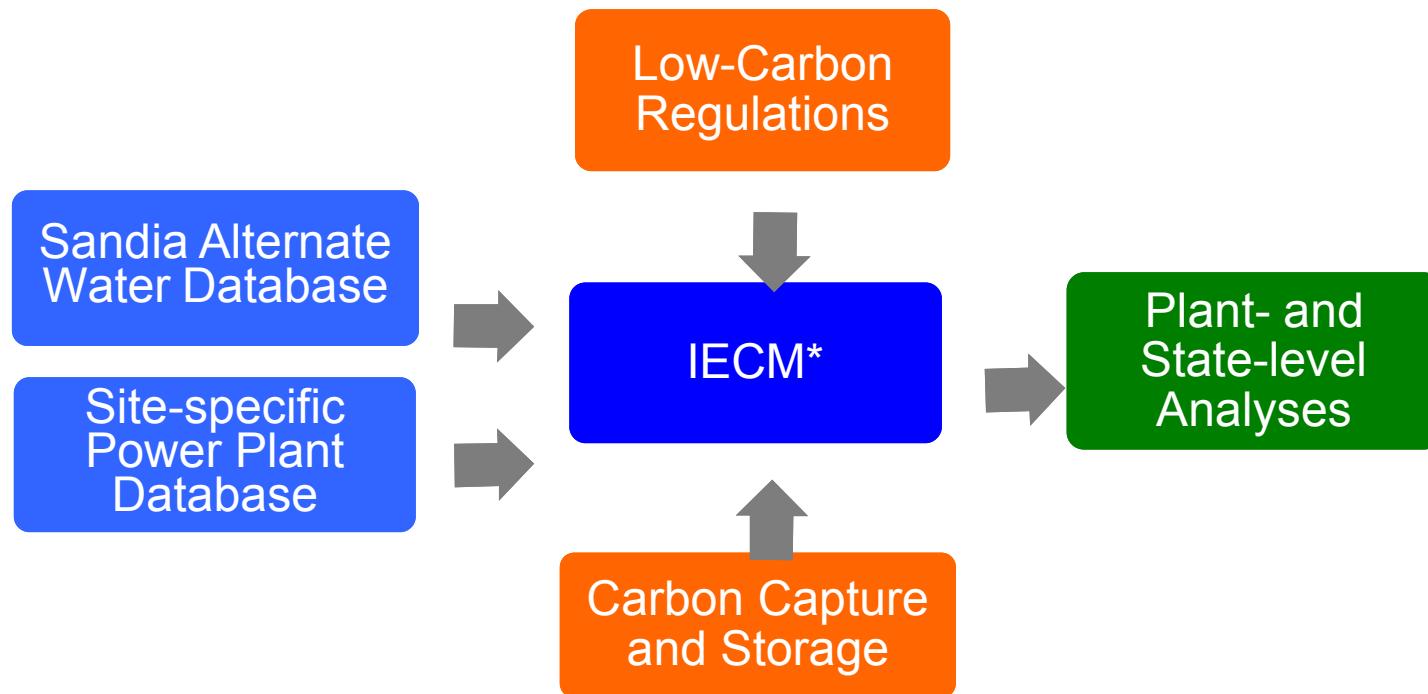
The study is led by the Eastern Interconnection States' Planning Council (EISPC). The research support and technical assistance to EISPC is provided by Argonne National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory. Funding is provided by the U.S. Department of Energy. [More >](#)

Partnering w/ Carnegie Mellon University:

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

- 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



Thank You



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.