

Exceptional service in the national interest



Exploring Energy-Water Issues in the United States

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Sandia National Laboratories

Crosscutting Research and Rare Earth Elements Review

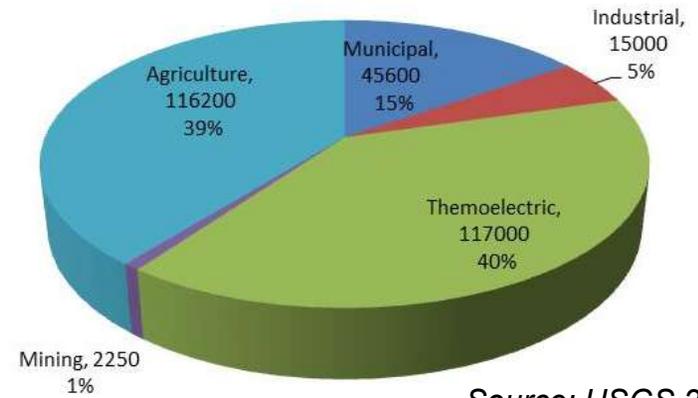
March 23, 2017



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.

Challenge

Thermoelectric energy production withdraws more water in the U.S. than any other use sector.



Source: USGS 2014

Energy-Water Nexus Issues are playing out all across the U.S.

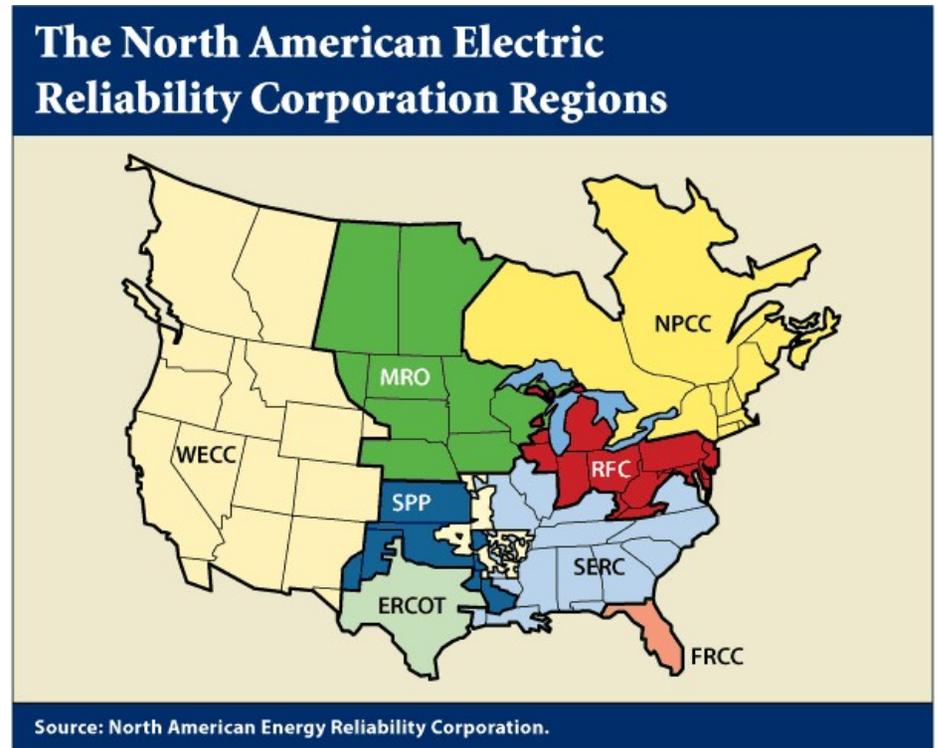
- Power plant outages
- Constrained hydropower
- Infrastructure damage by extreme events
- Curtailed energy resource extraction
- Permitting of New Facilities



Source: DOE 2013

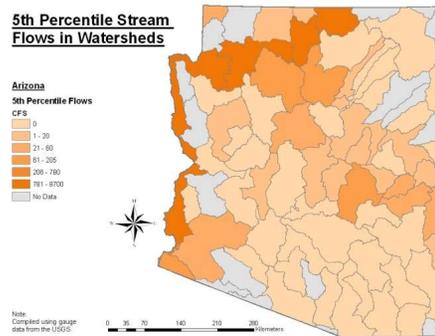
Need

- Interconnections are conducting long-range transmission planning (20 yrs.)
 - Siting of new power plants
 - New transmission capacity
- Where will the next drop of water come from?
- Develop a National Water Atlas at the watershed level (8-digit HUC, or roughly 2250 watersheds) to estimate:
 - Water availability,
 - Water cost, and
 - Competing demands.



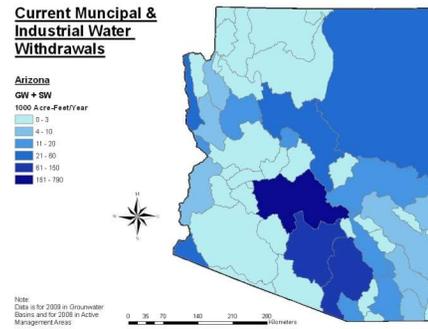
Methods: Collected Data from States

Water Supply



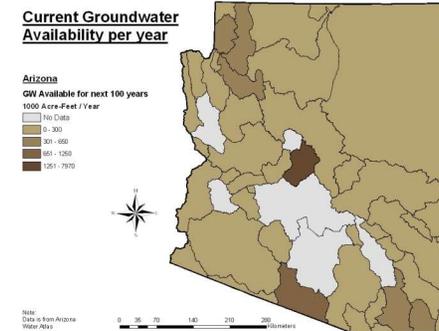
Mean Gauged Streamflow

Water Demand

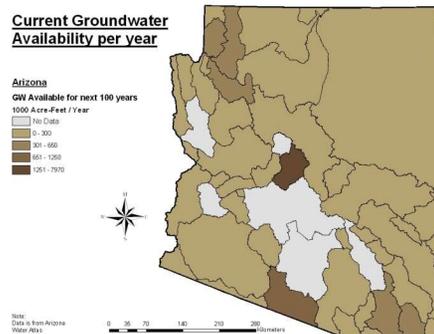


Municipal Demand

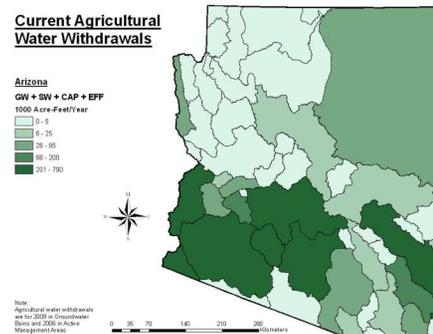
Water Institutions



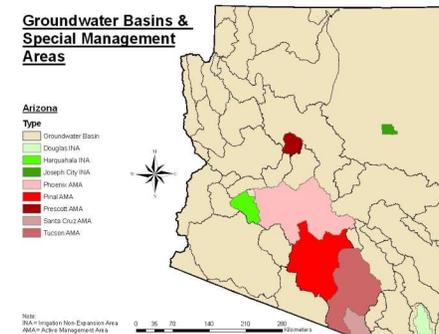
Unappropriated Water



Groundwater Depletion



Irrigation Demand



Administrative Control Areas

Methods: Metric Development

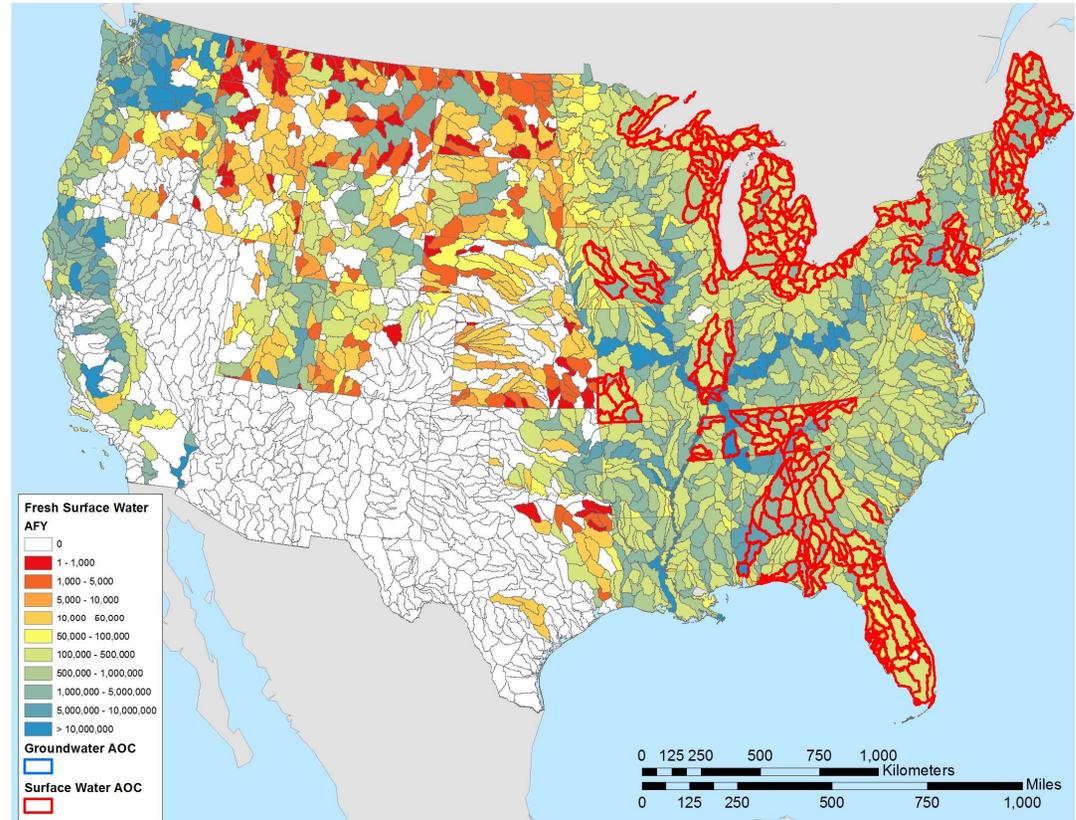
- **Data on “available water” are rare**
- **As such, metrics were estimated from available information**
- **Assisted by volunteer team from WSWC**
 - **Bret Bruce (USGS)**
 - **Dan Hardin (TX)**
 - **Sara Larsen (WSWC)**
 - **Dave Mitamura (TX)**
 - **Andy Moore (CO)**
 - **Ken Stahr (OR)**
 - **Todd Stonely (UT)**
 - **Steve Wolff (WY)**
 - **Dwane Young (WSWC)**

Water Availability: Fresh Surface Water

- **Surface water beyond current use that is available for new development.**
- **Based on environmental constraint:**

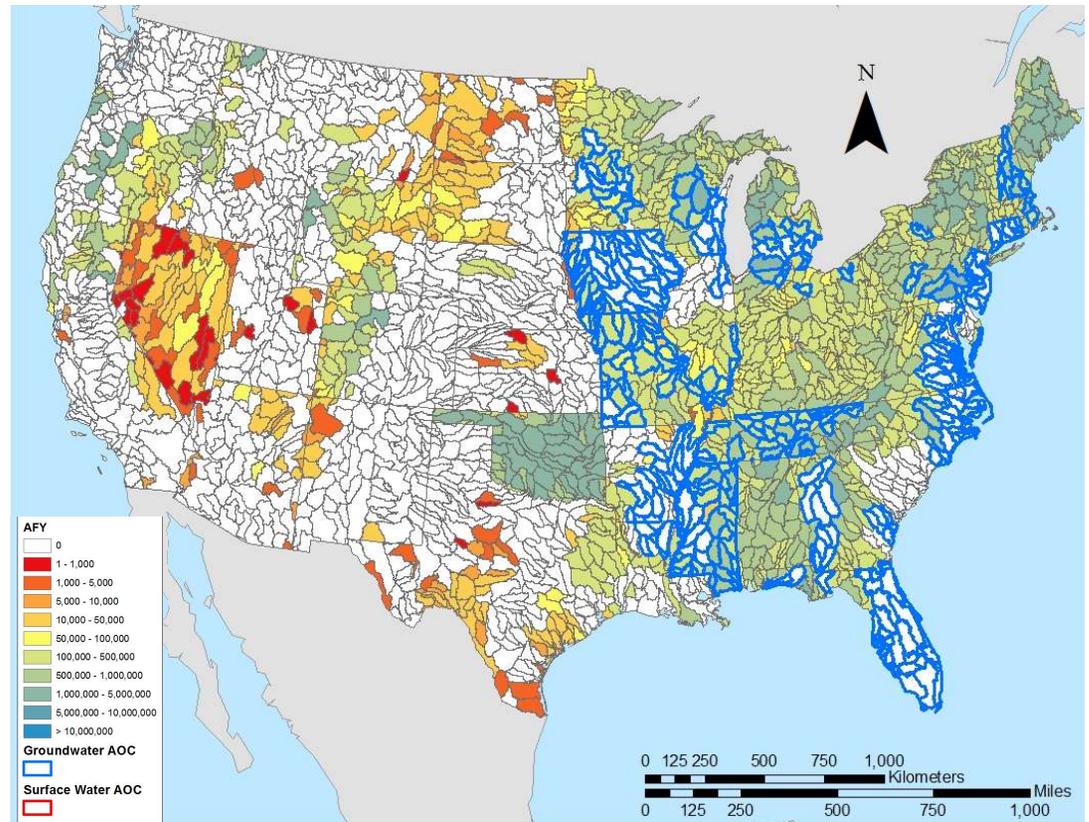
$$Q_{sw}^j = 0.5 * (Q_p^j + C^j) - C^j$$

- **Areas of Concern (basins outlined in red) designated regions requiring additional permitting.**



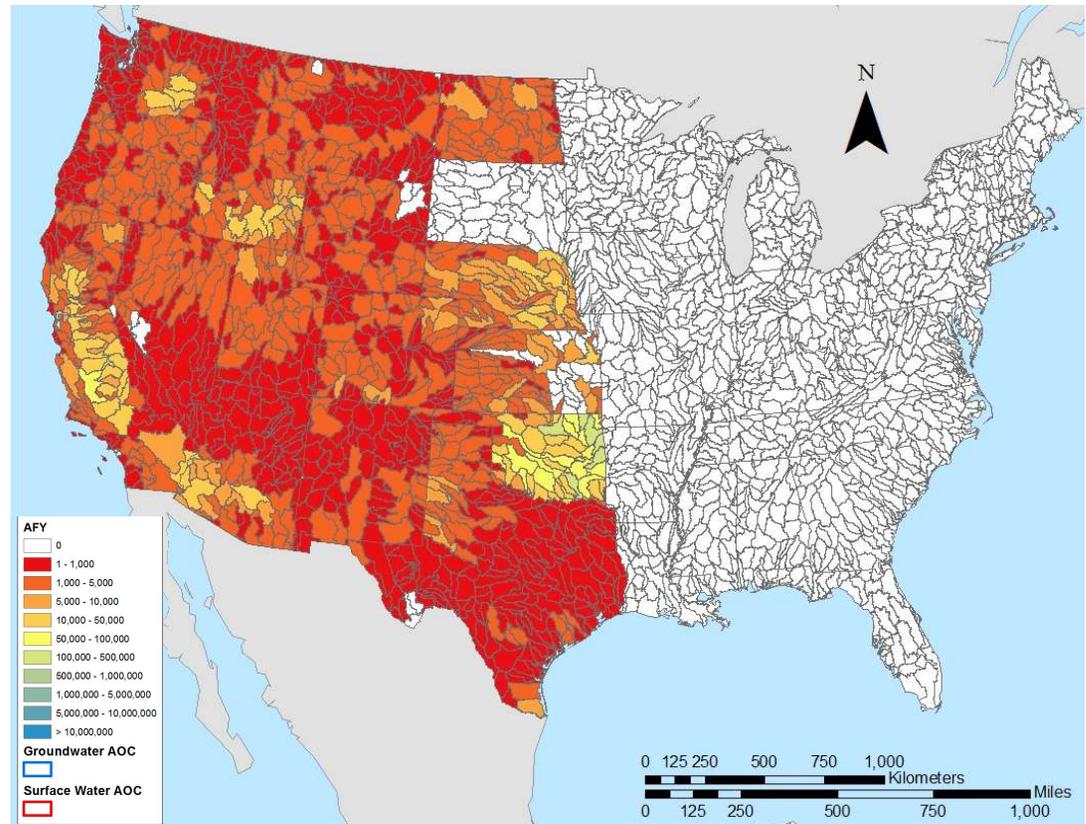
Water Availability: Fresh Groundwater

- Groundwater beyond current use that is available for new development.
- Difference between sustainable recharge and pumping while considering:
 - Areas of overdraft, and
 - Principle aquifers.
- Areas of Concern (basins outlined in blue) designated regions requiring additional permitting.



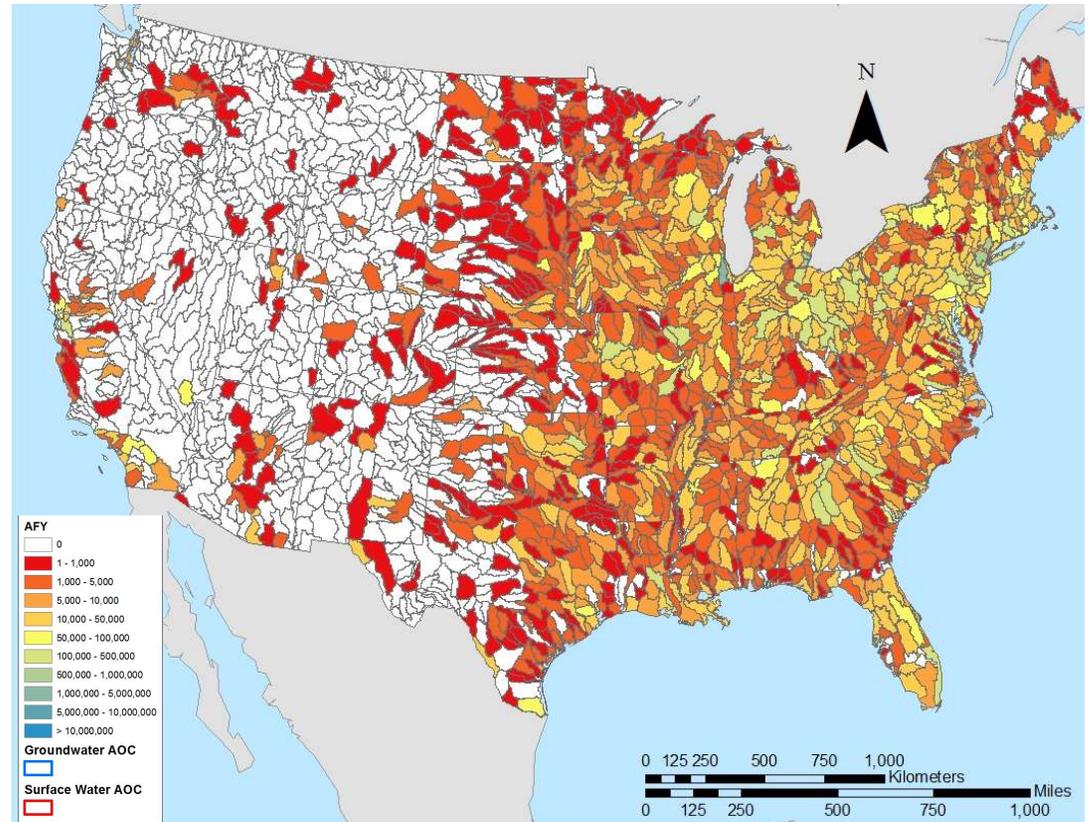
Water Availability: Appropriated Water

- **Water potentially available for transfer from one use to another (generally agriculture to municipal or industrial use)**
- **Limited to 5% of irrigation demand in any watershed based on feedback from state water managers.**



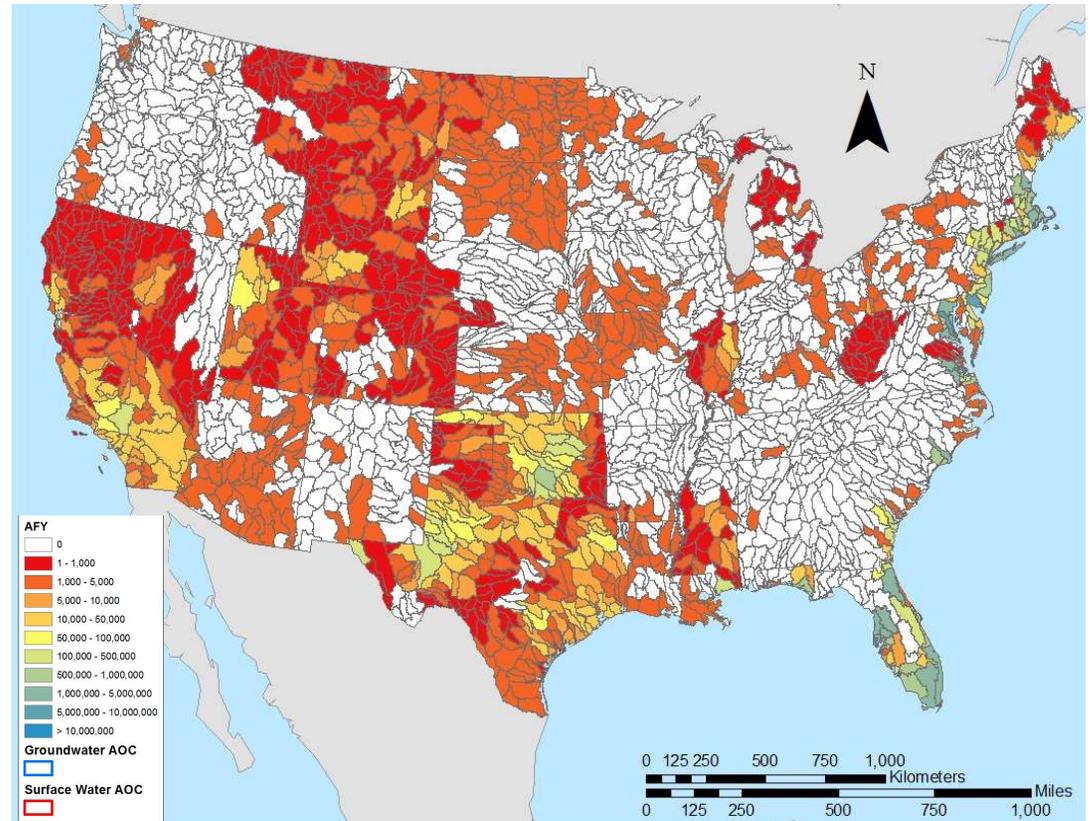
Water Availability: Wastewater

- **Projected future wastewater (2030) available for re-use.**
- **Reflects wastewater currently being reused.**



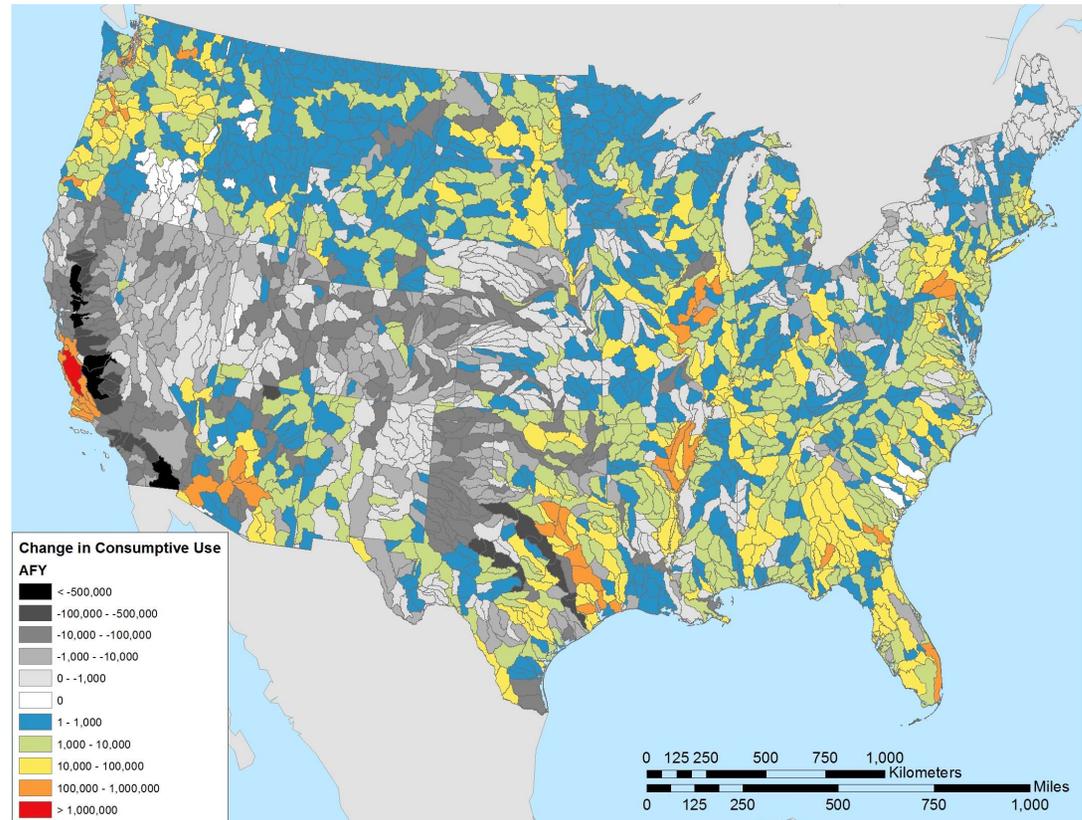
Water Availability: Brackish Groundwater

- Brackish water defined by salinities between 1,000 and 10,000 ppm TDS no deeper than 2500 ft.
- Estimates are data limited based on:
 - Current brackish water use, and
 - USGS well logs that indicated brackish water availability.



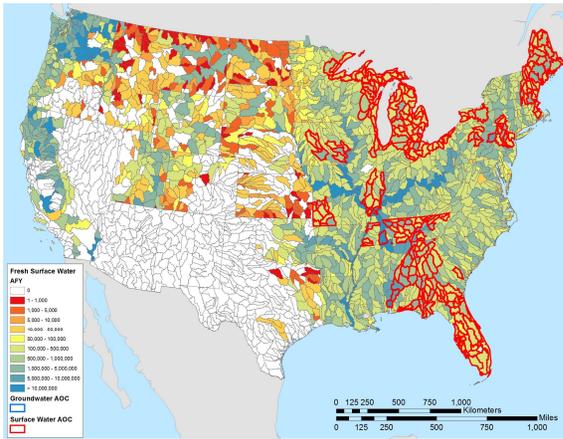
Projected Future Use 2010-2030

- Water needed for development after 2010.
- Based on estimates directly from states.
- Does not include thermoelectric water demand.

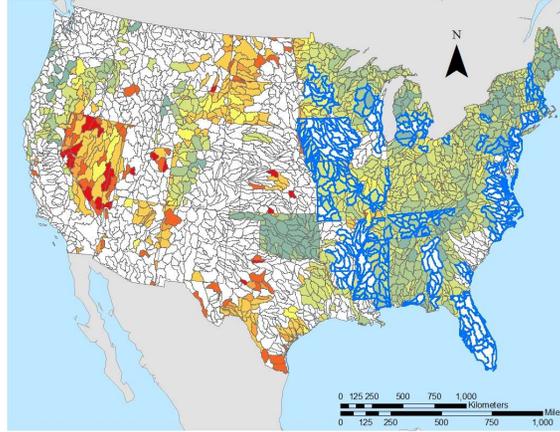


Water Supply Availability

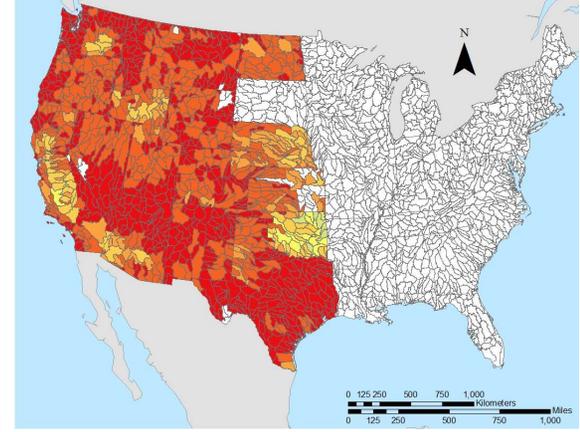
Fresh Surface Water



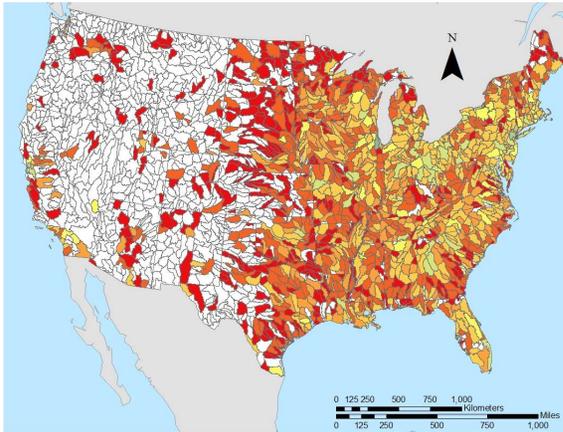
Fresh Groundwater



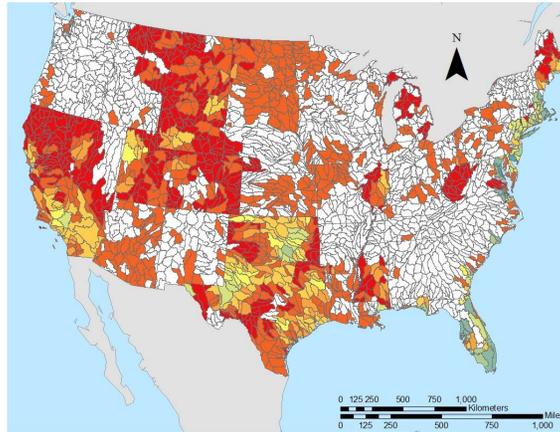
Appropriated Water



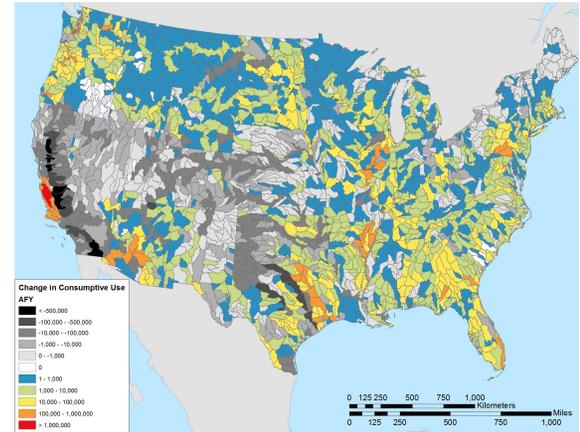
Municipal Wastewater



Brackish Groundwater



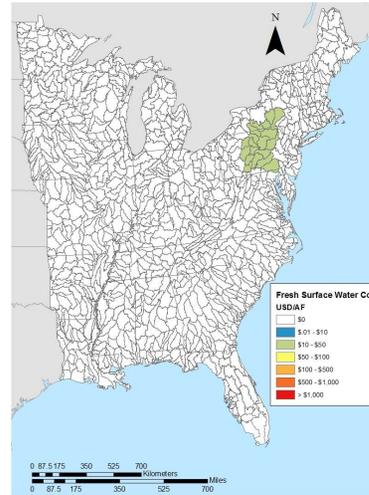
Consumptive Demand 2010-2030



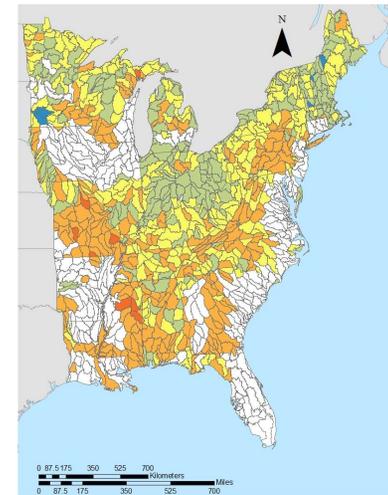
Water Cost

- Goal is to establish a consistent and comparable measure of cost to deliver water of potable quality to the point of use
- Basic costs considered:
 - Capital costs:
 - Purchase water,
 - Wells,
 - Conveyance, and
 - Treatment.
 - Operation and Maintenance:
 - Electricity,
 - Labor,
 - Consumables, and
 - Disposal.

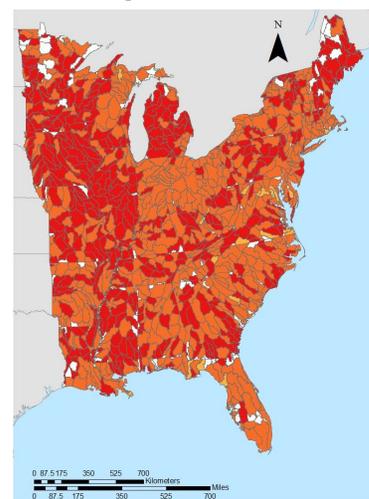
Fresh Surface Water



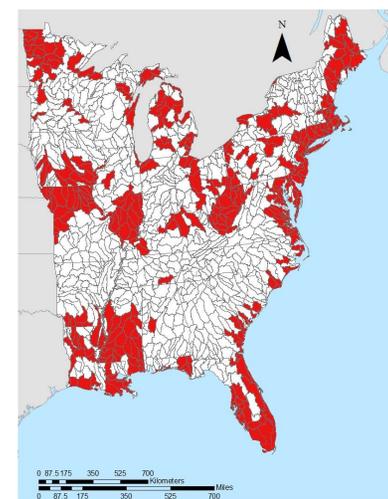
Fresh Groundwater



Municipal Wastewater



Brackish Groundwater



Data Access

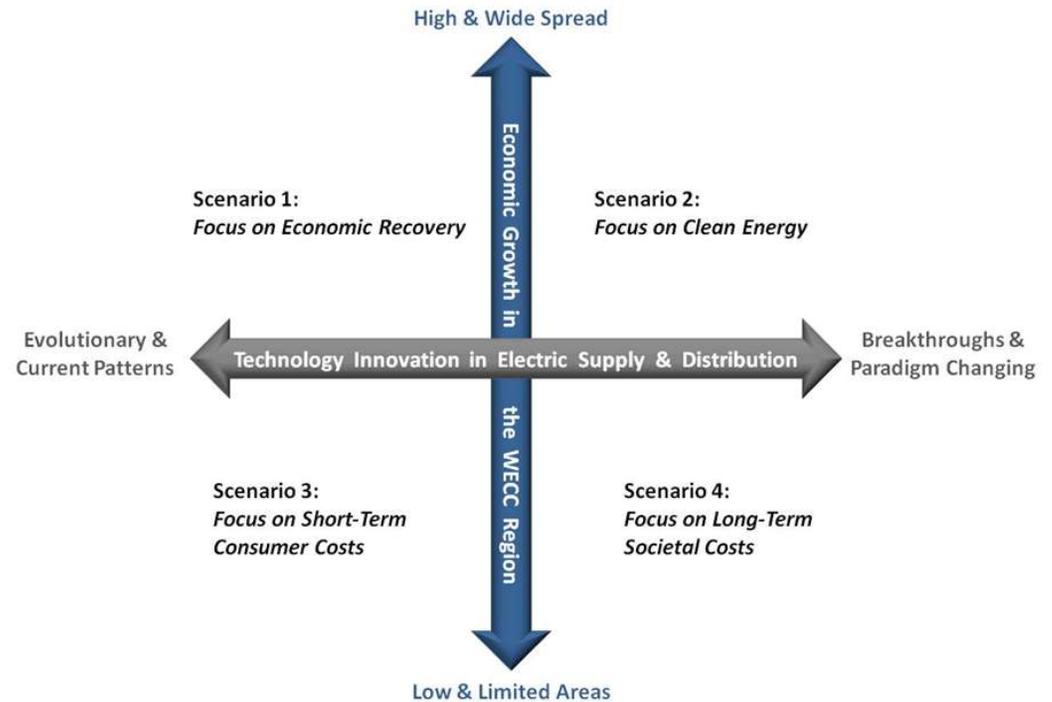
Project data available at:
<http://water.sandia.gov>

The screenshot shows the Sandia National Laboratories website. The main navigation bar includes 'Energy and Climate' and sub-sections like 'RENEWABLE SYSTEMS', 'CLIMATE/ENVIRONMENT', 'ENERGY INFRASTRUCTURE', 'ENERGY RESEARCH', and 'ABOUT EC'. The page title is 'Energy and Water in the Western and Texas Interconnects'. A secondary navigation bar includes 'Background', 'Objectives', 'Tasks', 'Benefits/Outcomes', 'Collaborators', 'Links', 'Documents', and 'Data Portal'. The main content area features a section titled 'Water Scarcity Impacts Energy Production' with a sub-header '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:'. Below this are three bullet points: 'Hydroelectric power generation', 'Thermoelectric power plant cooling and air emissions control', and 'Energy-resource extraction, refining, and processing'. Three images illustrate these topics: a power plant, a cooling tower, and a wind turbine. A text block states: '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:'. This is followed by three bullet points: 'Limitations of surface-water storage capacity', 'Increasing depletion and degradation of ground water supplies', and 'Increasing demands for the use of surface water for in-stream ecological and environmental uses'. A social media sharing bar is visible. On the right, there are two sidebars: 'WATER SECURITY PROGRAM' with a sub-section 'Energy and Water in the Western and Texas Interconnects' containing links to 'Energy and Water Data Portal', 'Electric Power Generation and Water Use Data', and 'Water Availability, Cost, and Use'; and 'ENERGY-WATER DATA PORTAL' featuring a map of the United States. The page footer includes 'Last Updated: August 7, 2014' and a 'Go To Top' link.

The footer section is titled 'Exceptional service in the national interest' and is organized into five columns: 'EC', 'EC Highlights', 'EC Top Publications', 'Related Topics', and 'Connect'. The 'EC' column lists 'About Energy and Climate (EC)', 'Energy Security', 'Climate Security', 'Infrastructure Security', 'Energy Research', 'Key Facilities', and 'Partnerships'. The 'EC Highlights' column lists several recent reports and awards, including 'Sandia Report Presents Analysis of Ozone Impacts of Henschel Solar Power Site', 'Sandia Wins Award for Best Poster at 49th IEEE Photovoltaic Specialist Conference (PVSC)', 'Sandia Completes Hydrostructural Analysis of Ocean Renewable Power Company's 10MWes P1 Turbine', and 'The Influence of Rotor Blade Design on Wake Development'. The 'EC Top Publications' column lists 'Solar Energy Grid Integration Systems: Final Report of the Florida Solar Energy Center Team' (4.71 MB), 'Modeling System Losses in PVsyst' (365.05 KB), and 'Improved Test Method to Verify the Power Rating of a Photovoltaic (PV) Project' (319.74 KB). The 'Related Topics' column lists 'Concentrating Solar Power', 'CSP EPRC Energy', 'Energy Efficiency Energy', 'Security Infrastructure', 'Infrastructure Security National Solar Thermal Test Facility', 'NSTIF photovoltaic', 'Photovoltaics PV', 'Photovoltaics PV Renewable Energy solar Solar', 'Energy solar power Solar', 'Research Solid-State', and 'Lighting SSLs'. The 'Connect' column lists 'Contact Us', 'RSS', 'Google+', 'Twitter', 'Facebook', 'LinkedIn', 'YouTube', and 'iStock'.

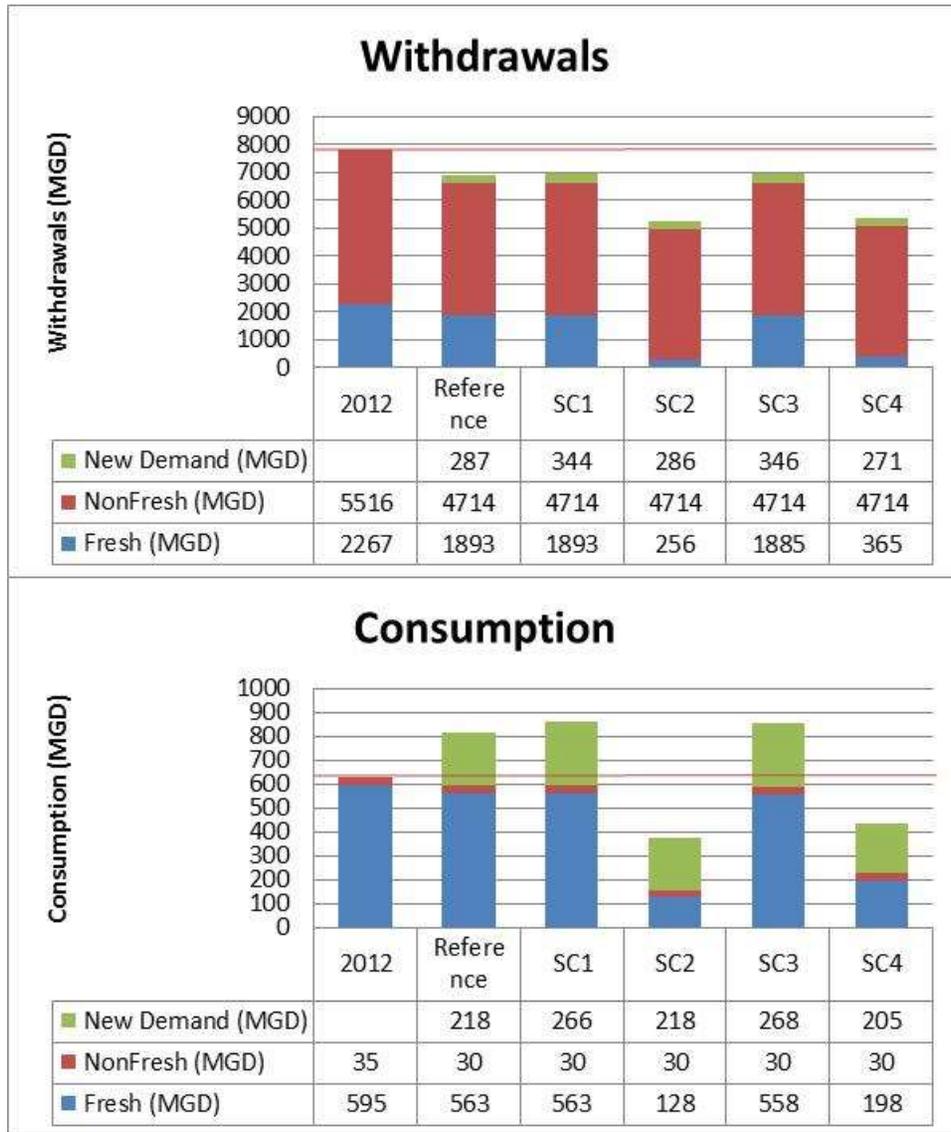
Planning: Scenario Development

- **Reference Case:** adopted trajectory of recent WECC planning information.
- **Scenario One:** favored continued trends in growing use of natural gas and renewables.
- **Scenario Two:** distinct shift toward renewables, energy efficiency and significant carbon tax.
- **Scenario Three:** reliance on traditional technologies while simply meeting current state renewable portfolio standards.
- **Scenario Four:** similar technology development and policies as in scenario two except limited by sluggish economic growth.



Source: WECC 2013

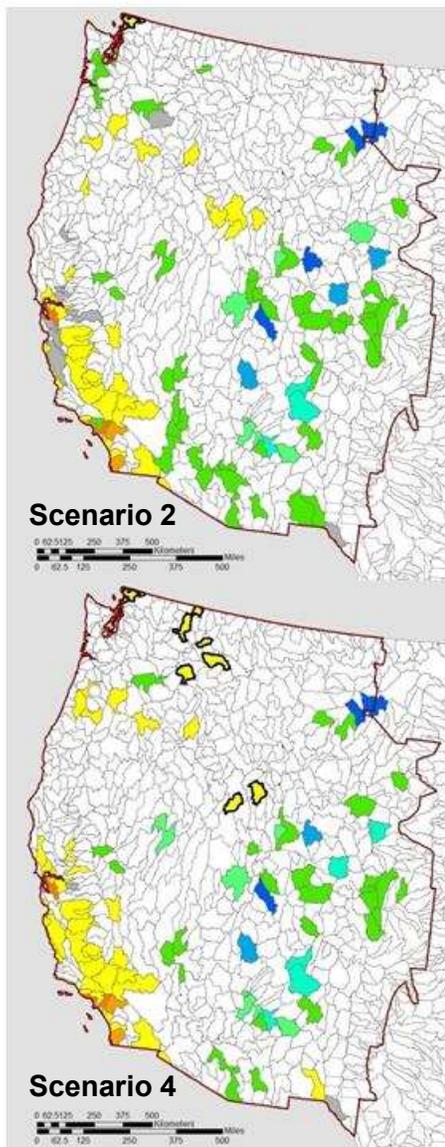
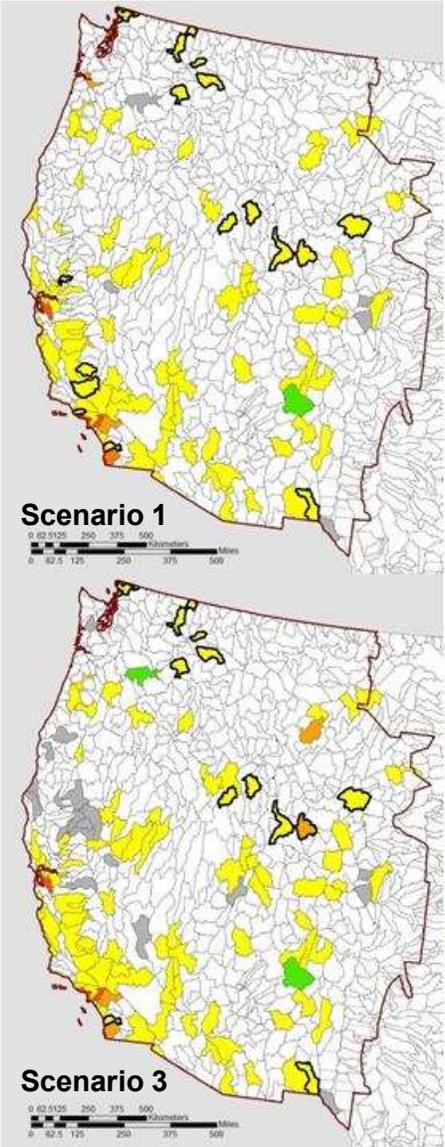
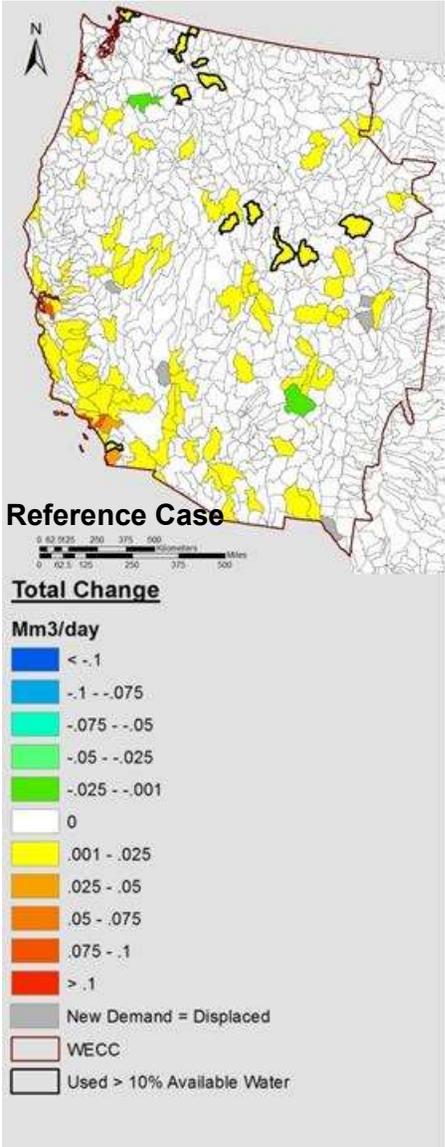
Planning: Water Use



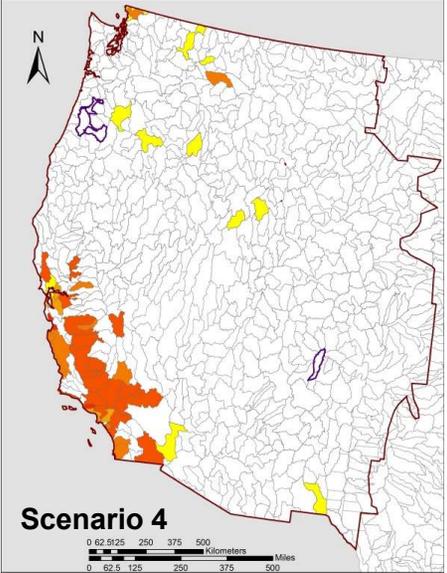
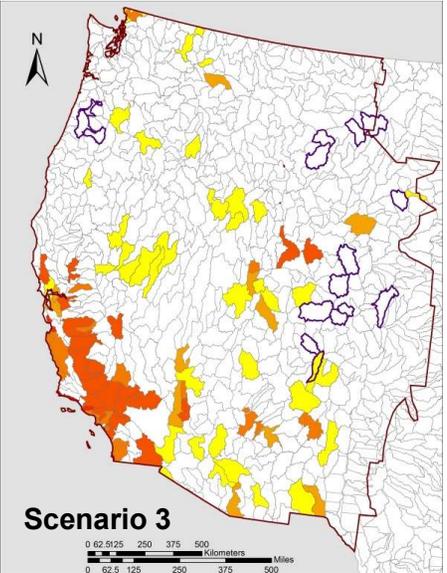
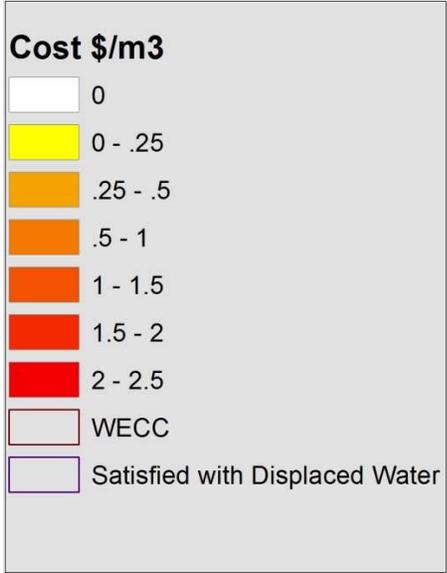
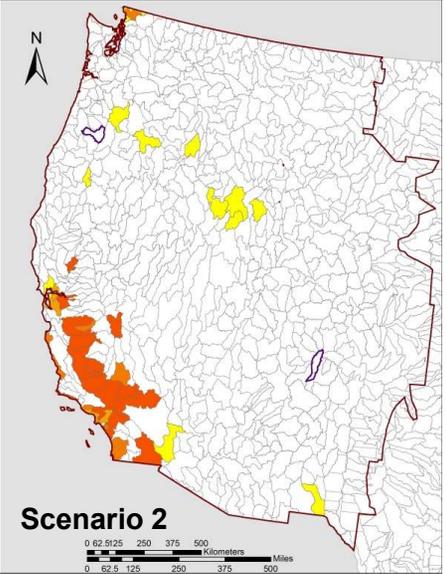
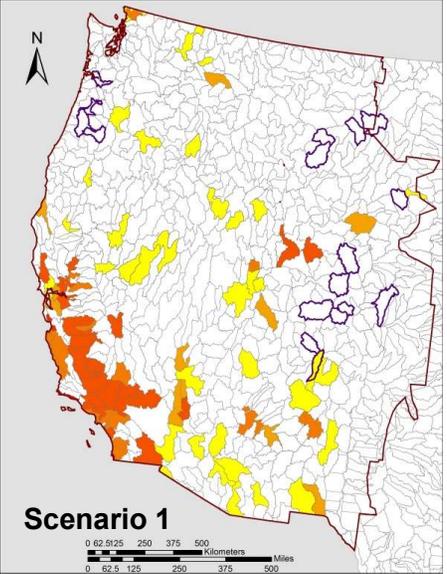
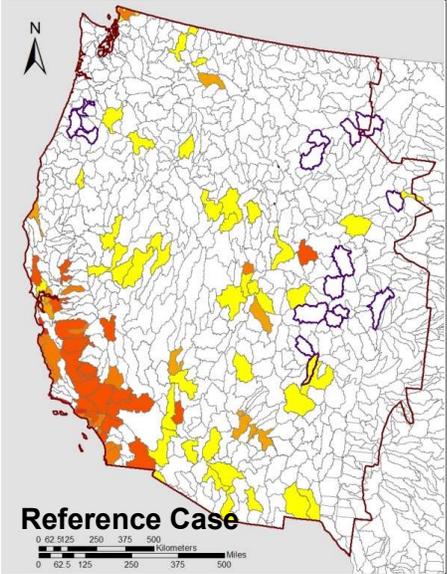
- Uniform reductions in withdrawals:
 - Similar additions across scenarios,
 - Retirements of 14% of seawater and 4 % freshwater withdrawals,
 - >70% displacement of freshwater withdrawal in scenarios 2 and 4

- Consumption varies by scenario:
 - Uniform additions,
 - >30% decrease for scenarios 2 and 4 (displaced coal)
 - >30% increase for other scenarios

Planning: Watershed Impact

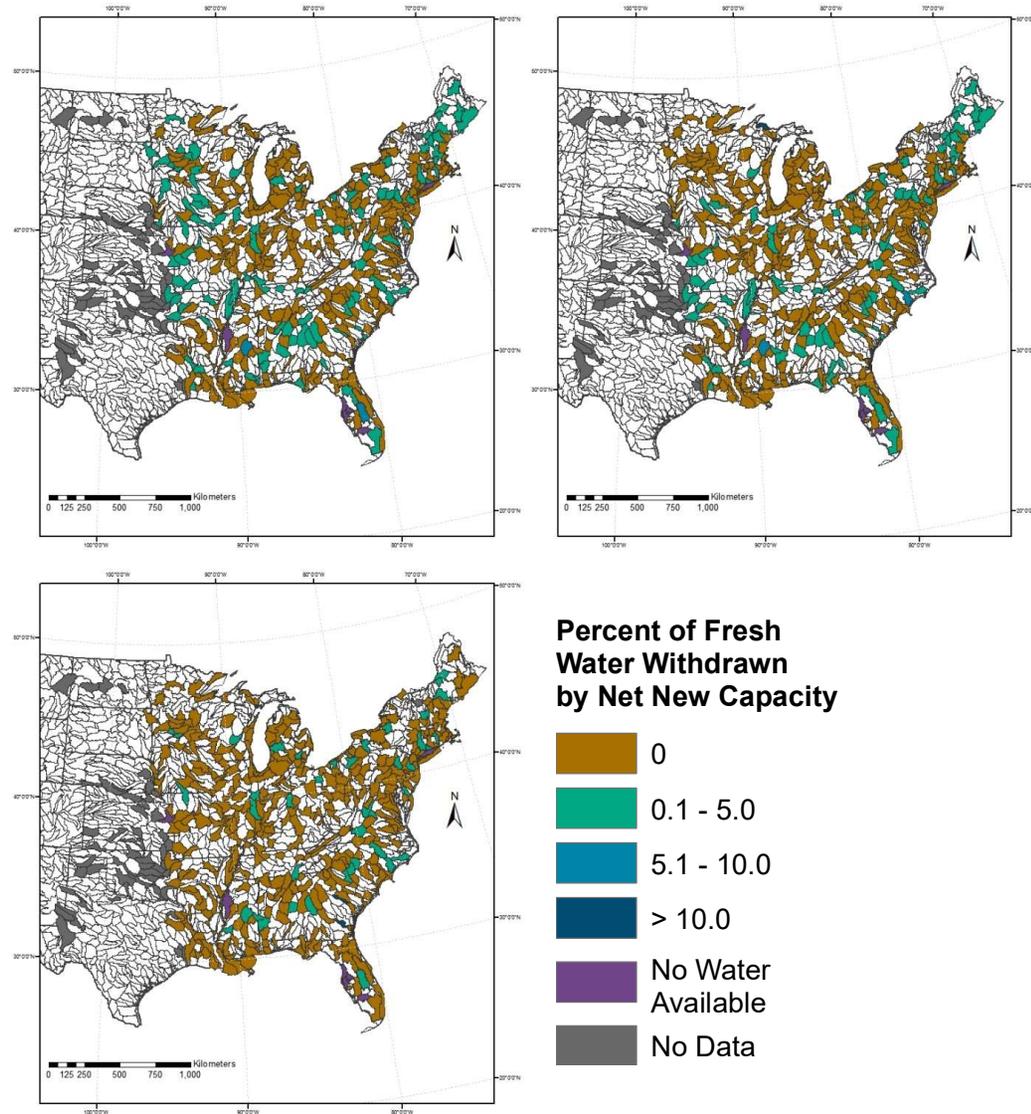


Planning: Watershed Cost Analysis



Planning: Watershed Impact

- Three scenarios
 - Business as Usual
 - High renewables
 - Emission controls
- Significant retirement of high-water use capacity to retire
- Freshwater able to meet future demands except in rare instances



Planning: EISPC EZ Mapping Tool

Help | Login | Register

EISPC EZ Mapping Tool

Home | About the Study | Energy Resources | Data | Policies & Regs | Maps | Documents | Links | [Launch Tool](#)



EISPC EZ Mapping Tool

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

[Launch Tool](#)

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 [policies 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 collocation 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.



We are interested in your feedback. Please email your comments to ezmt@anl.gov.

News

March 16, 2016
[New Energy Infrastructure and Related Data](#)
The following energy infrastructure layers, and related themes, have been added to the...

March 15, 2016
[Updates to Commercially Licensed Data](#)
Due to expiration of the commercial license on **March 15**:
• The following...

March 01, 2016

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 >](#)



Version 2 (M)

The Courtesy of MapQuest

Water Atlas: Next Generation

- Scoping study to envision decision support system to inform technology and supply choices related to water for energy:
 - Planning for new development, and
 - Planning system up-grades at existing facilities.
- Propose basic system framework.
- Propose basic content while identifying potential sources of information.