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Integrating Water in Electric Transmission Planning

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Environmental Vision-An International Electricity Sector Conference

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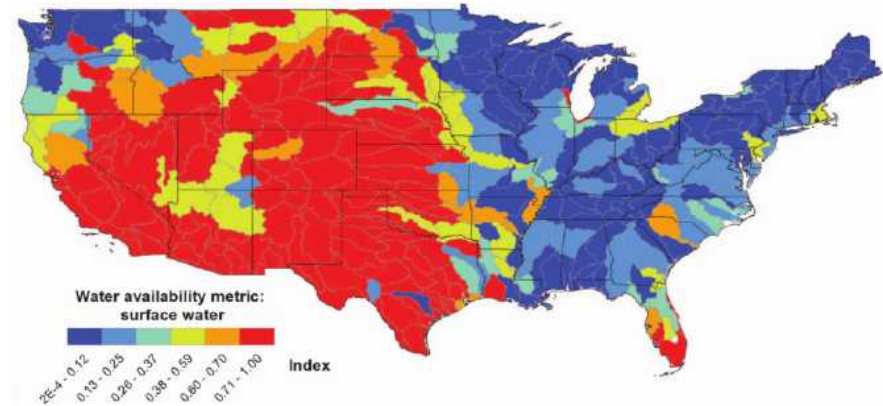


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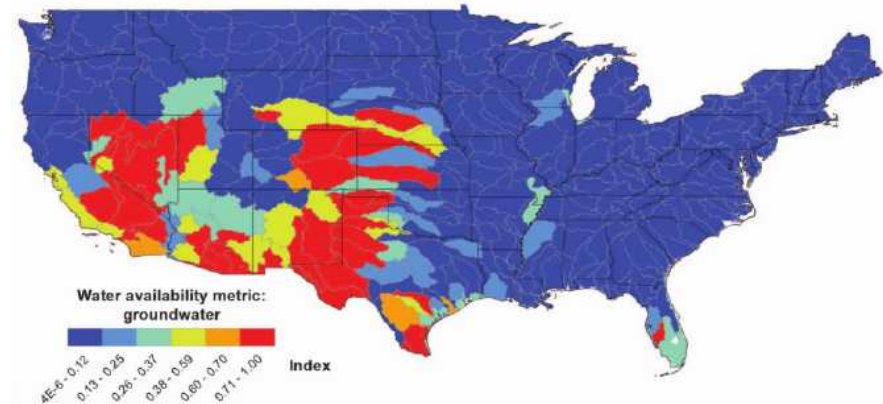
The Challenge

- Where is water for a growing electric sector going to come?
- Significant competition of available supplies of water.
- Available water supplies are not uniformly distributed over the United States.
- Historically, limited interaction between water and electric expansion planners.

Surface Water Availability



Groundwater Availability

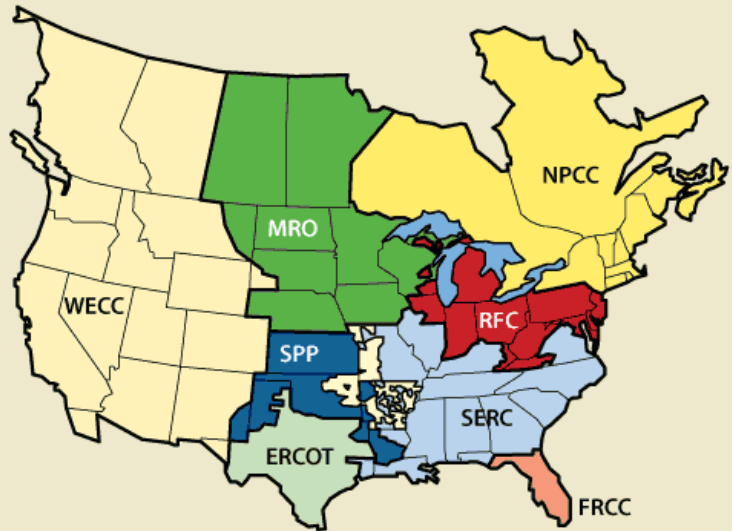


Objective

- Integrate water related concerns into long-range transmission expansion planning (20 yrs.) of WECC:
 - Siting of new power plants
 - New transmission capacity



The North American Electric Reliability Corporation Regions



Source: North American Energy Reliability Corporation.



**WESTERN
GOVERNORS'
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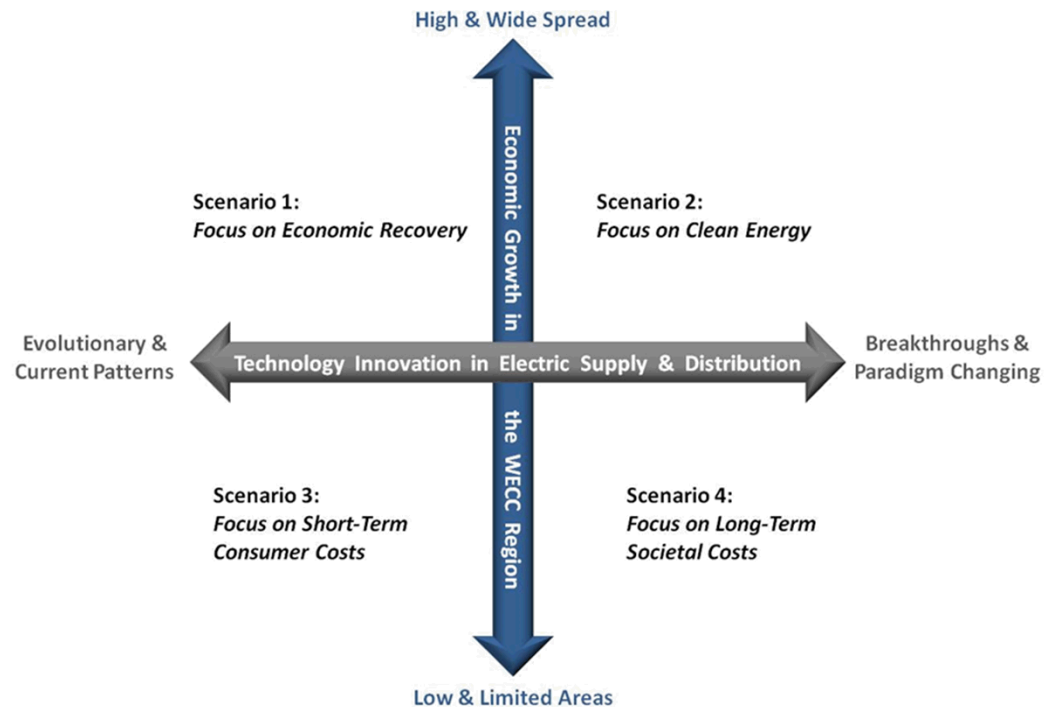


WSWC

Western States Water Council

Methods: 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.

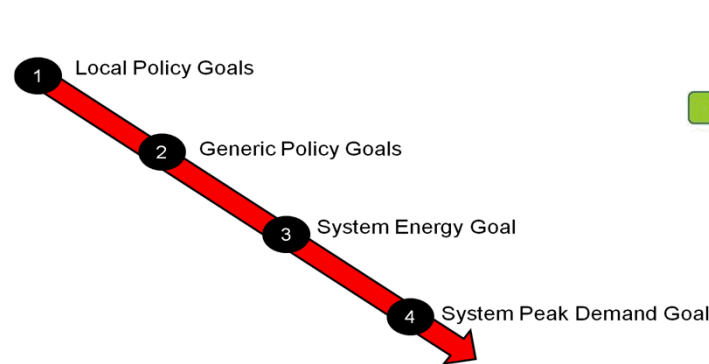
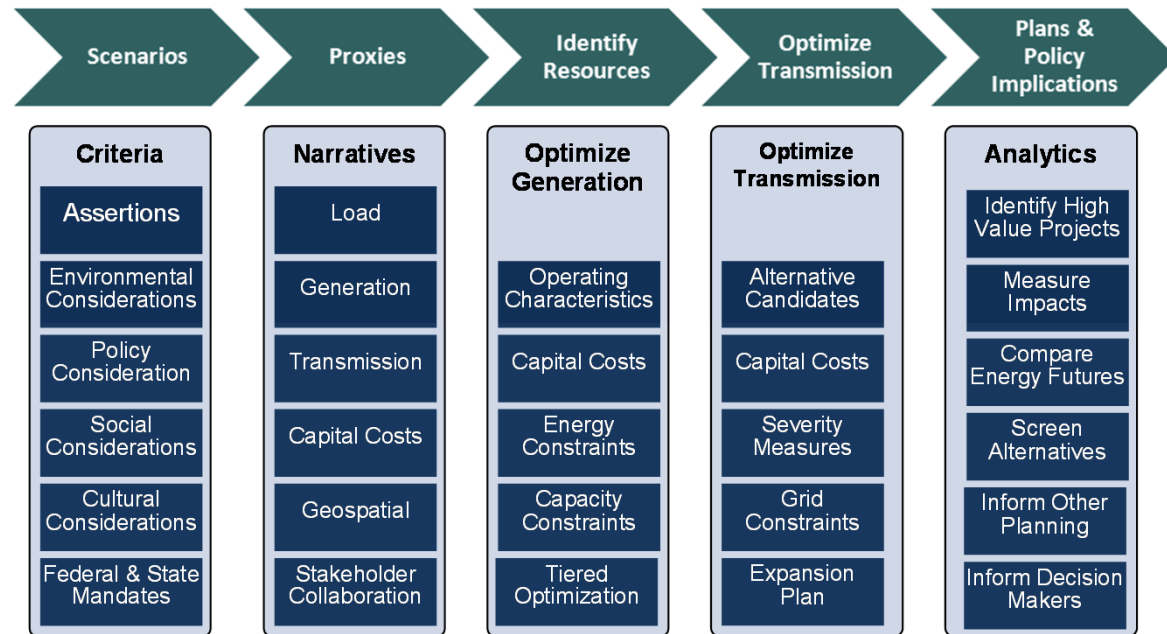


Source: WECC 2013

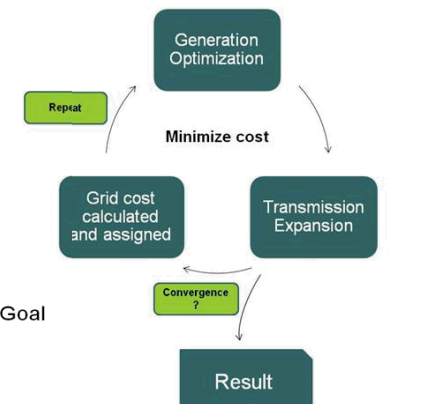
Methods: Capital Cost Expansion Tool

Source: WECC 2013

- Co-optimize generation and transmission additions.
- Least cost solution subject to goal related constraints:
 - Energy,
 - Policy,
 - Environmental, and
 - Societal conditions.
- Water is one of many considerations.



*Generation Selection
Structuring of Goals*

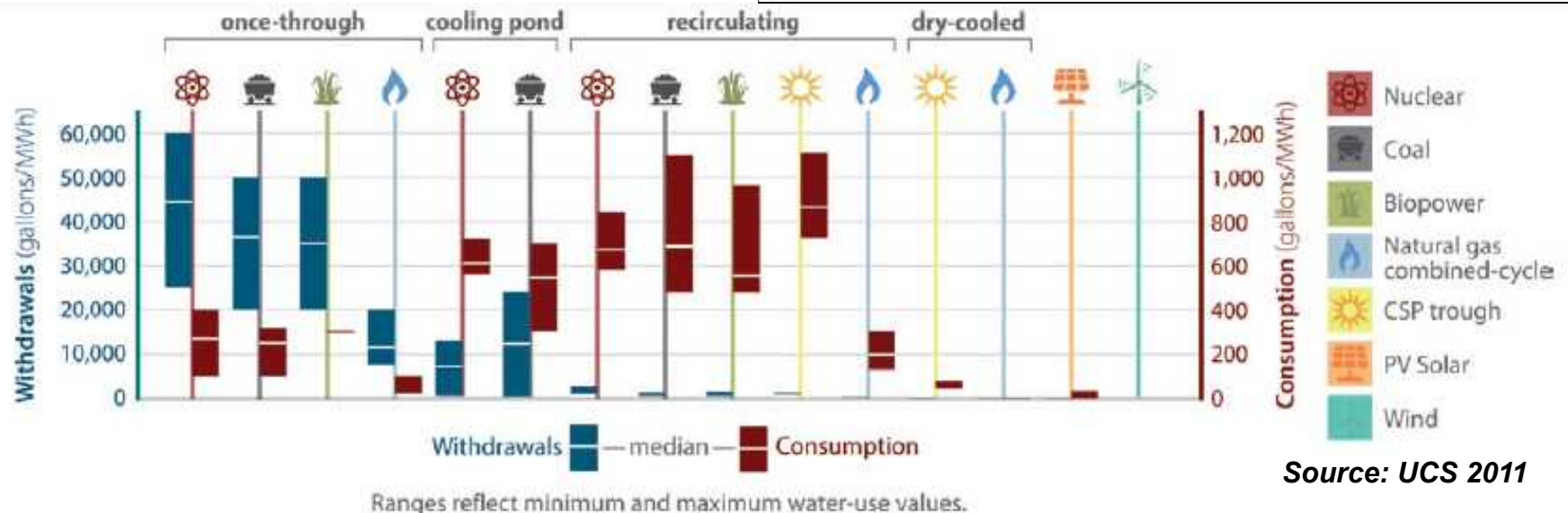
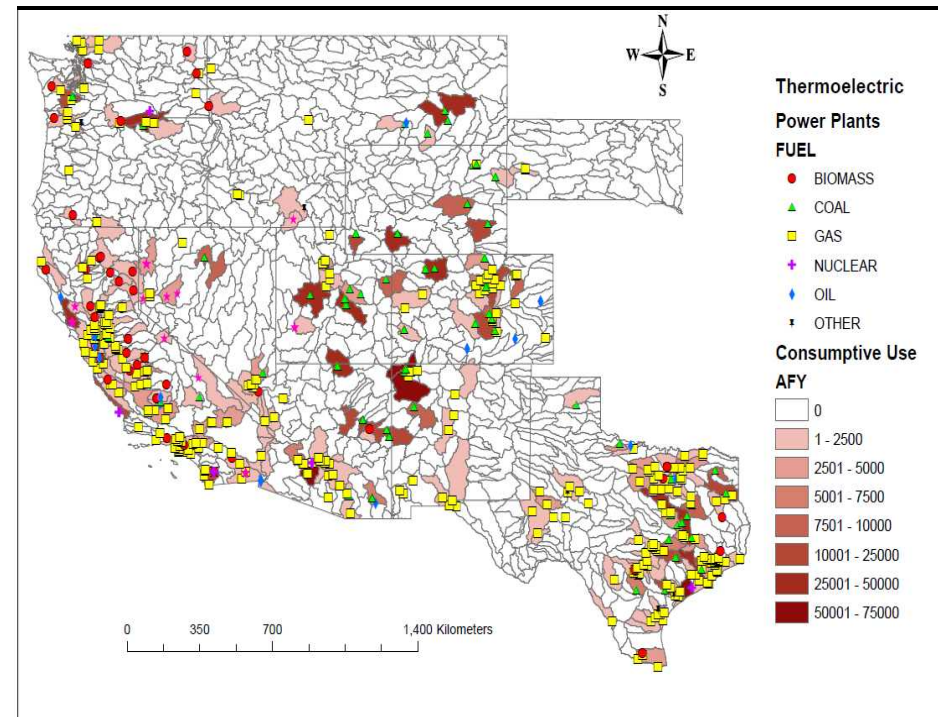


Optimization Iteration

Methods: Water for Thermoelectric Power

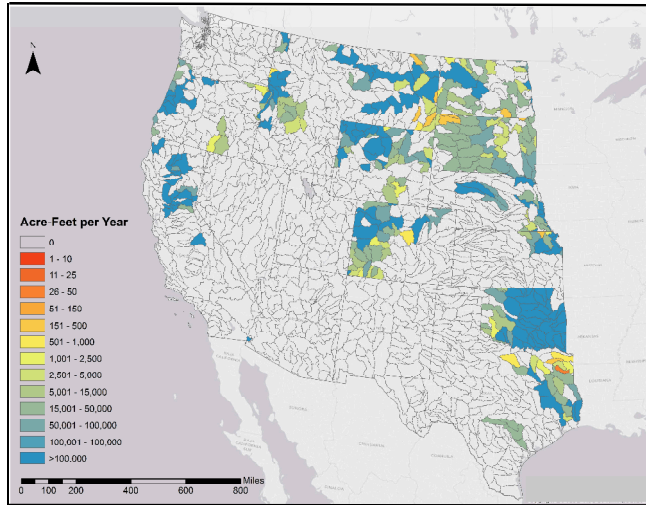
- Water withdrawal and consumption at existing power plants
- Water intensity of future thermoelectric power plants

Water Consumption for Existing Power Plants

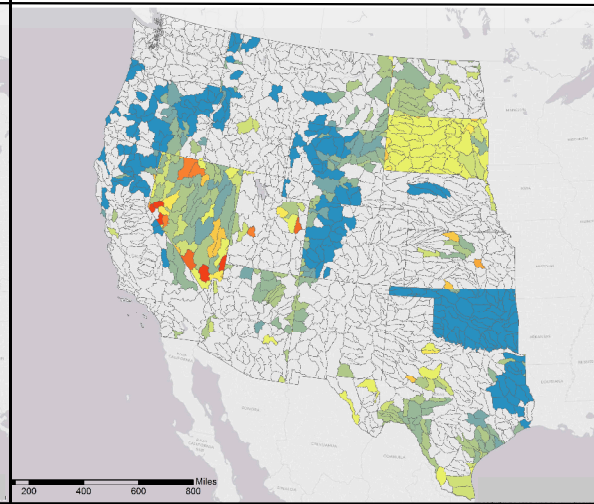


Methods: Water Supply Availability

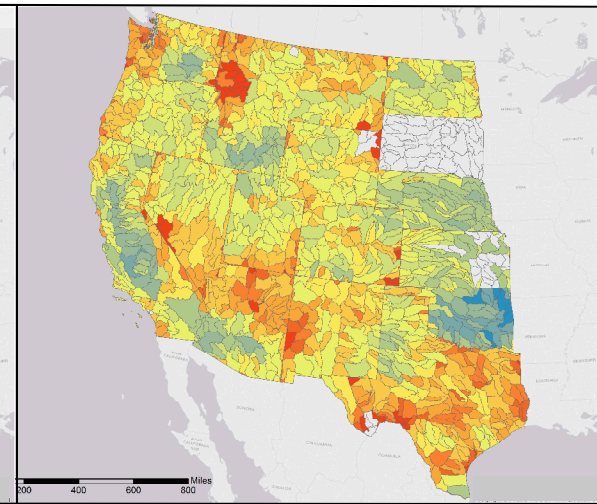
Unappropriated Surface Water



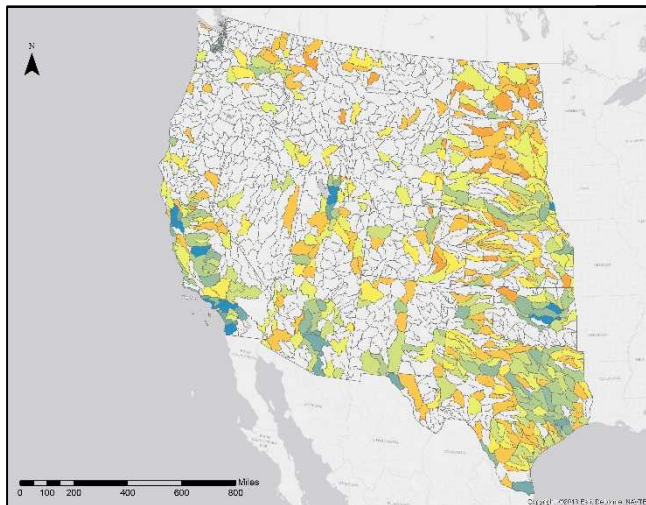
Unappropriated Groundwater



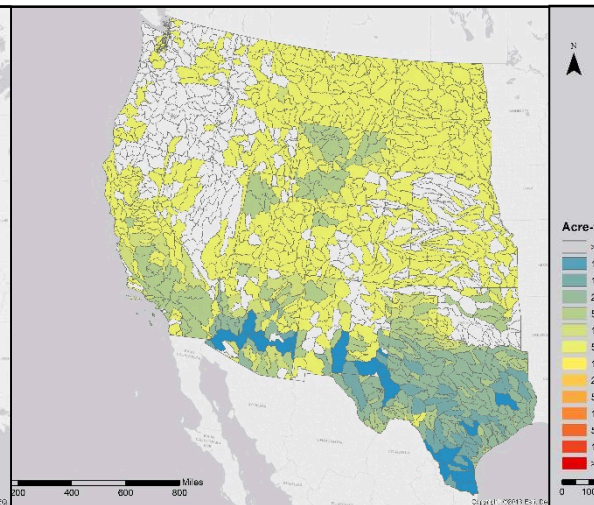
Appropriated Water



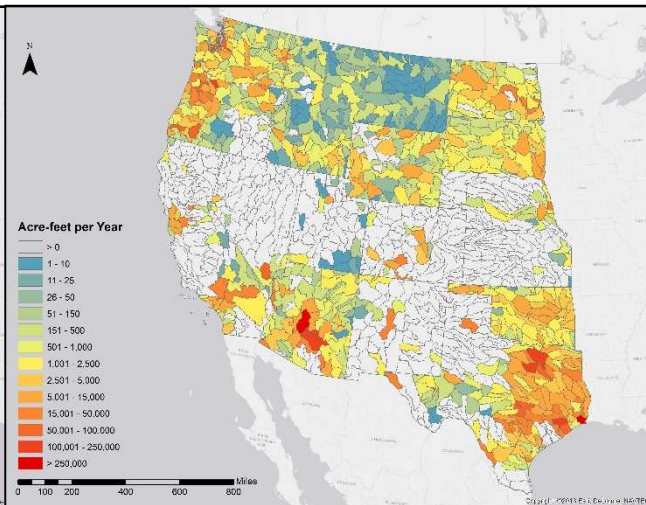
Municipal Wastewater



Brackish Groundwater



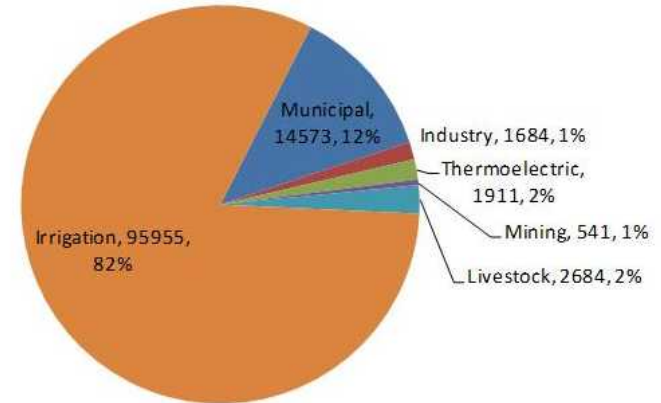
Consumptive Demand 2010-2030



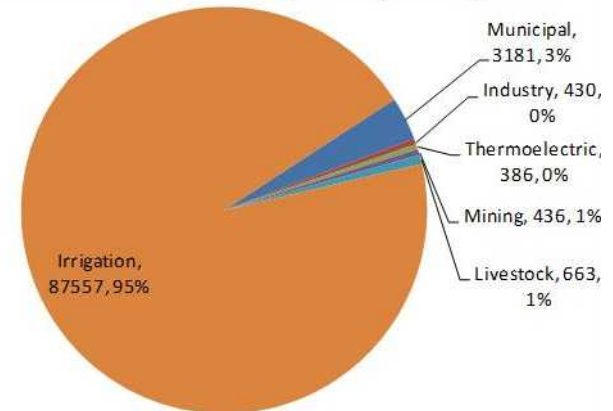
Results: Understanding Current Use

- Current thermoelectric water use is small relative to other sectors:
 - ~2 percent of withdrawals, and
 - <<1 percent of consumption.
- Largely result of closed loop cooling in West and high agricultural irrigation.
- Issue facing planners is not current use but where is the next drop of water coming from to meet *future use*?

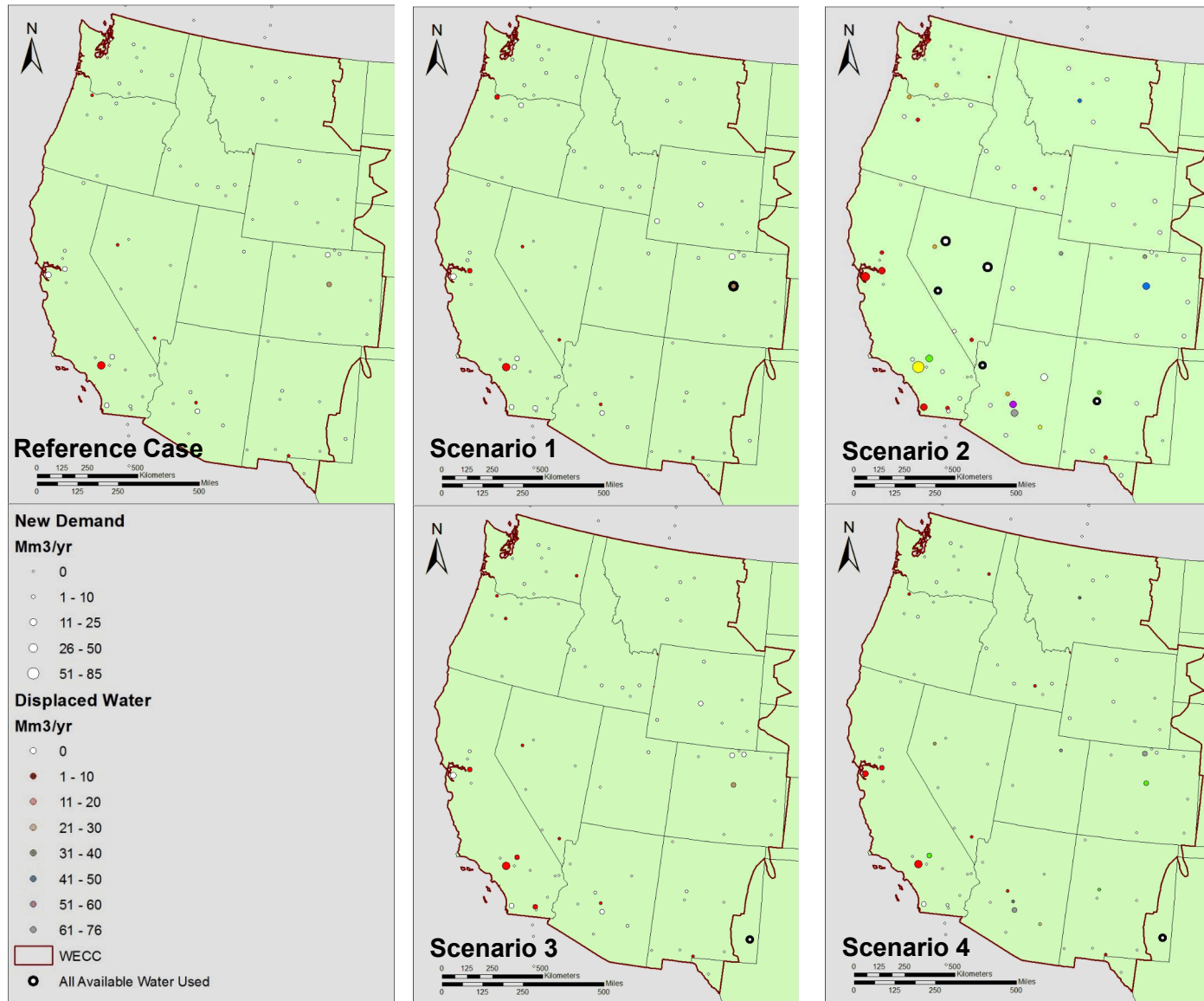
2010 Water Withdrawal (MGD)



2010 Water Consumption (MGD)

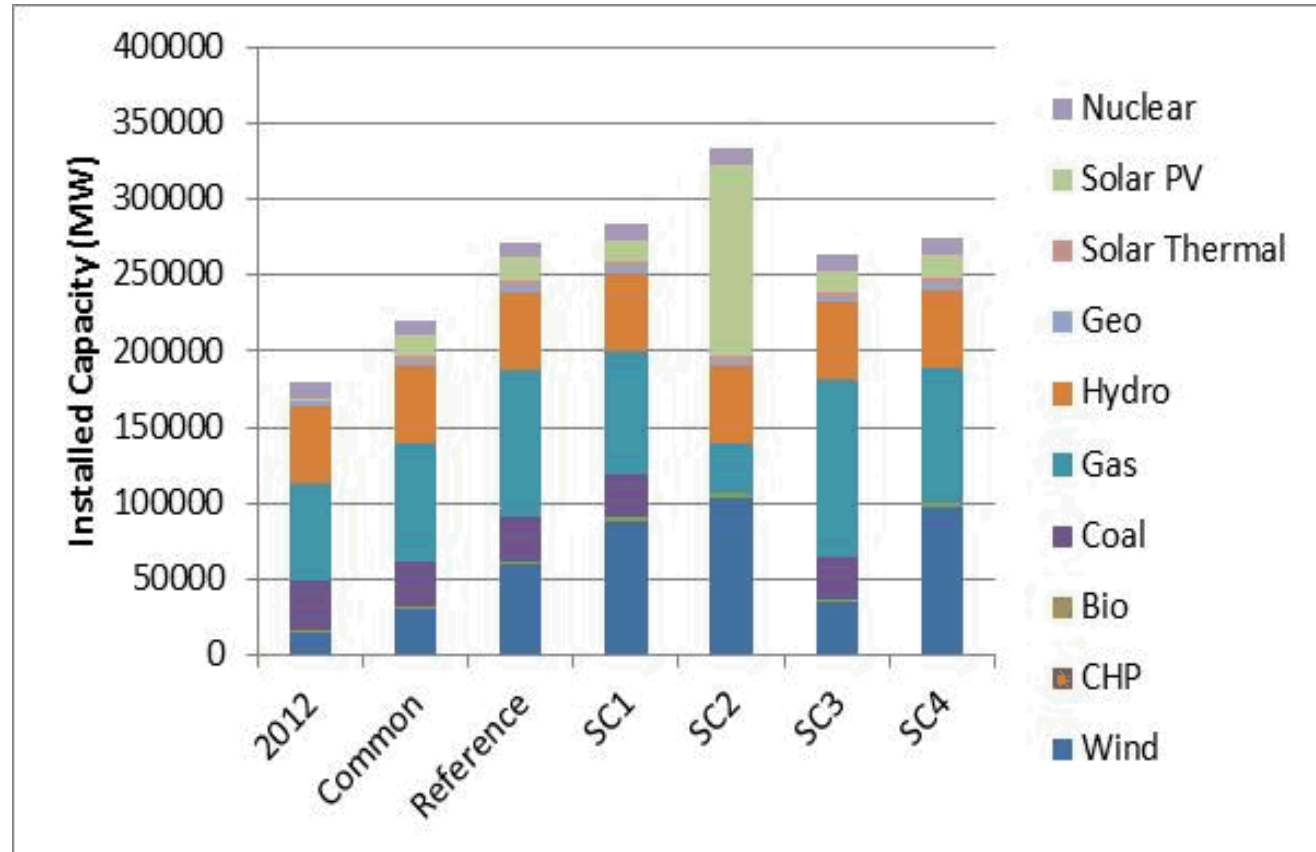


Results: Water Constraint

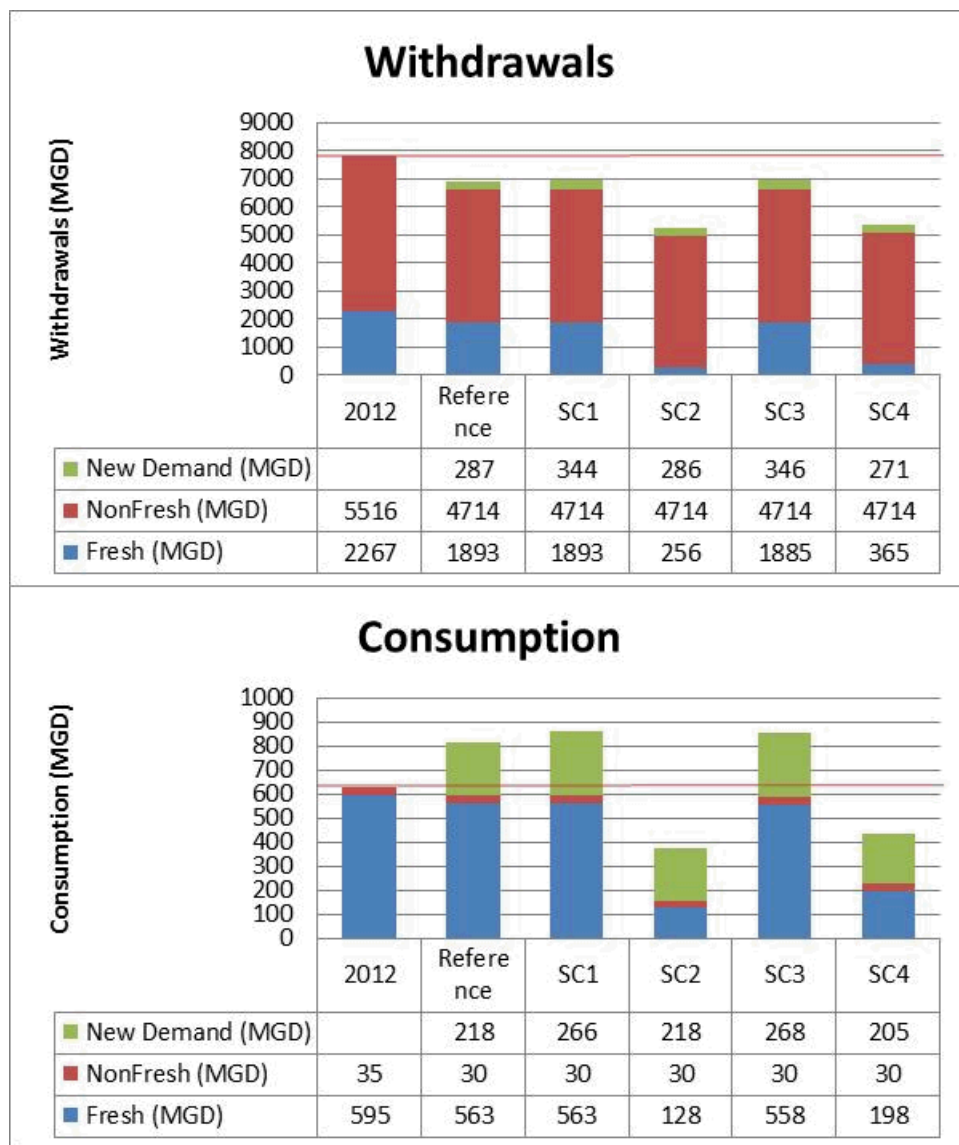


Results: Generation Expansion

- Uniform mix of additions across five scenarios:
 - Natural Gas Combined Cycle,
 - Wind, and
 - Solar PV.
- Coal generation displaced in Scenarios 2 and 4 due to emission policies.

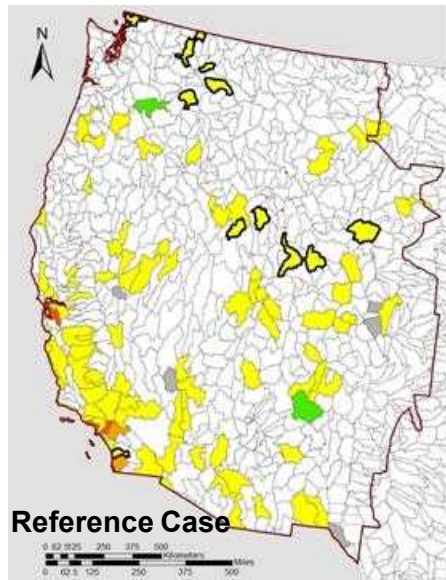


Results: Water Use



- 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

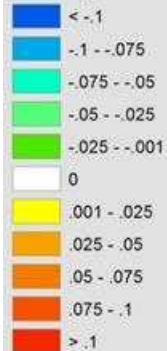
Results: Watershed Supply Analysis



Reference Case

Total Change

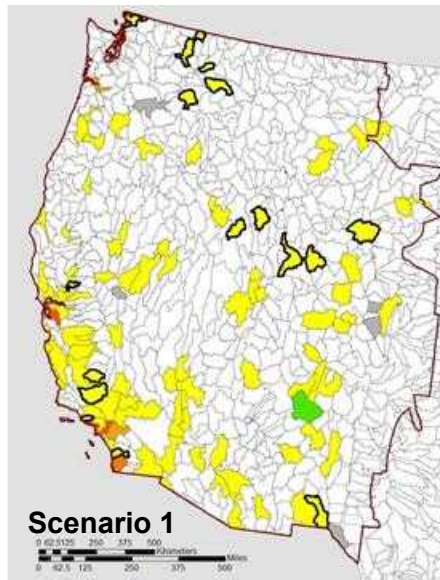
Mm3/day



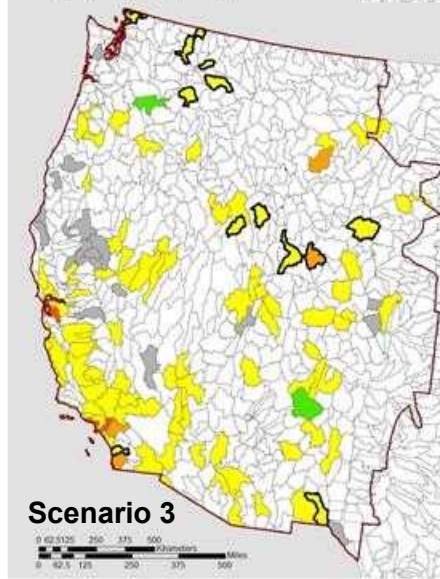
Gray box: New Demand = Displaced

Pink box: WECC

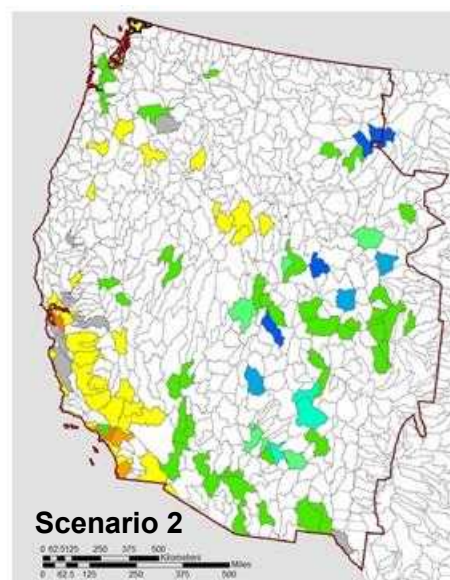
White box: Used > 10% Available Water



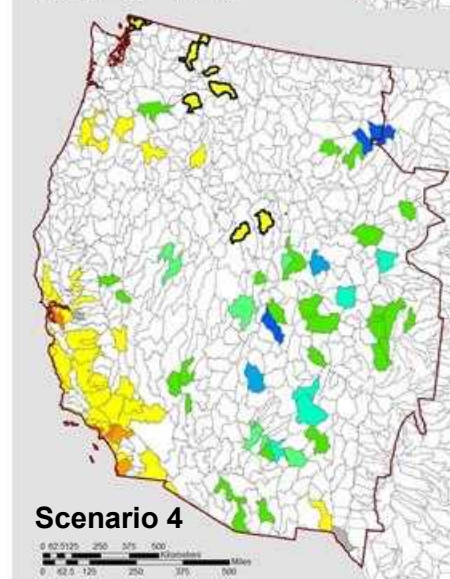
Scenario 1



Scenario 3

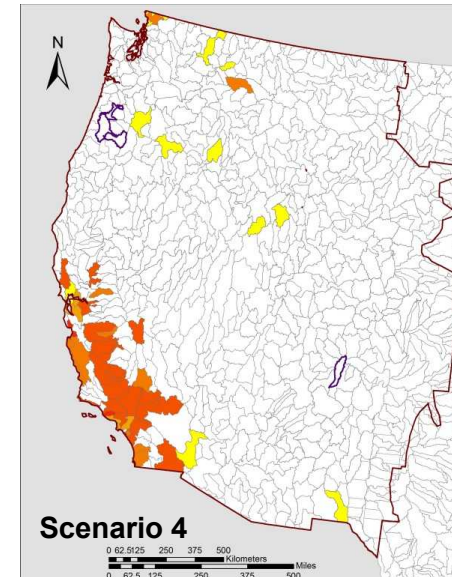
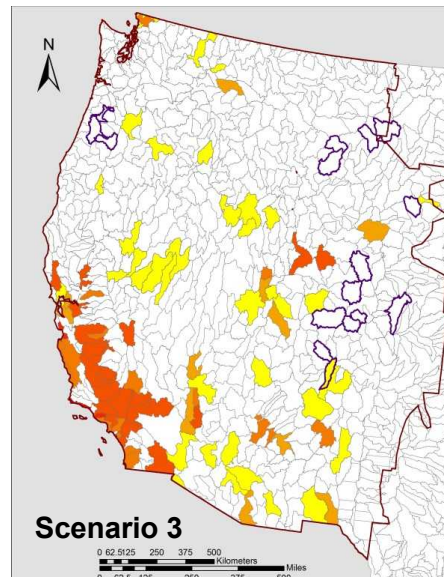
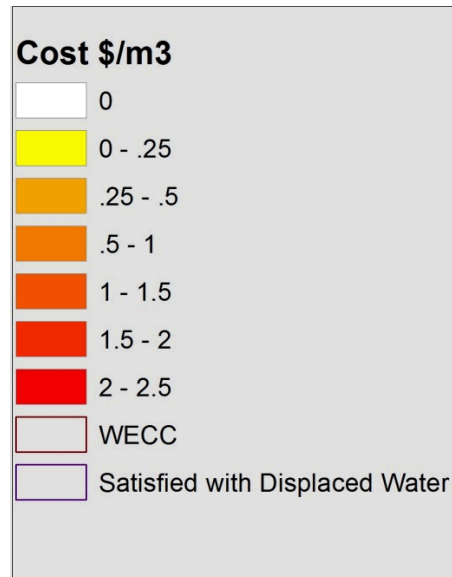
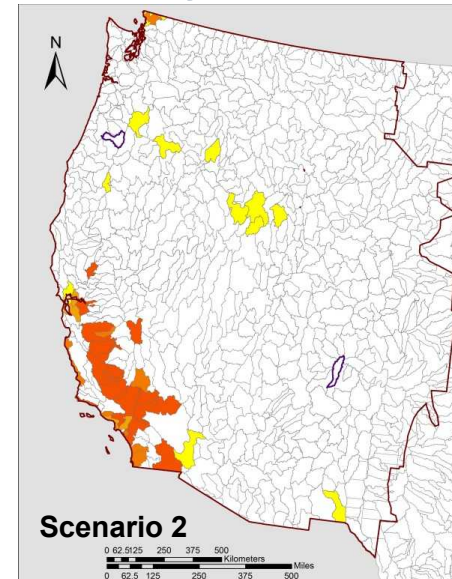
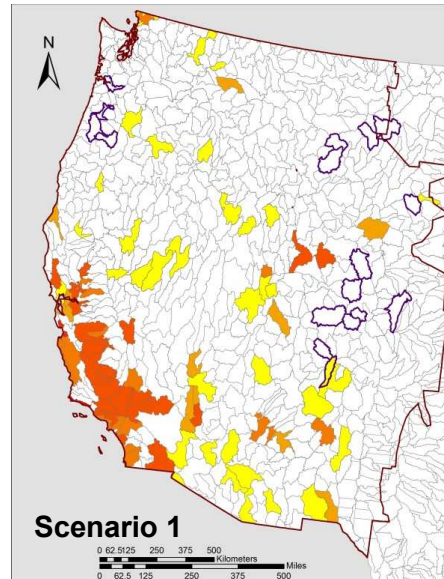
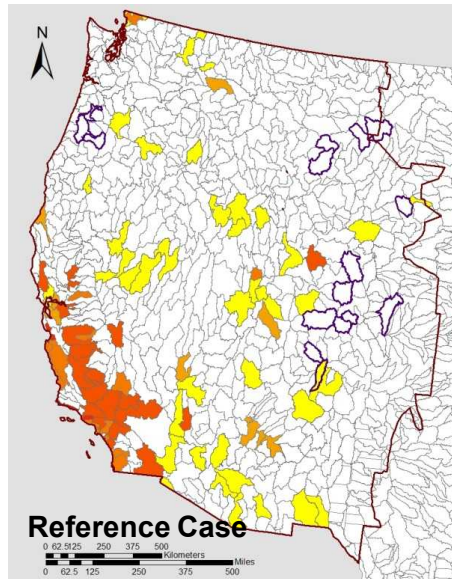


Scenario 2



Scenario 4

Results: Watershed Cost Analysis

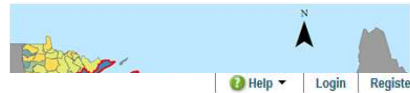


Takeaways

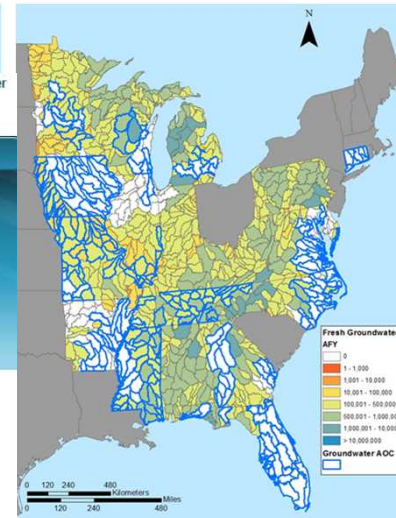
- Time and effort required to begin to “speak the same language.”
- Factors indirectly related to water (e.g., technology cost, energy policy) had greatest influence on future thermoelectric water use.
- Big difference in water use across scenarios, 30+% increase to a 30+% decrease in water consumption.
- Thermoelectric expansion can occur with limited impact on water resources of the West.
- Expansion will likely require increased use of non-traditional waters.

Eastern Interconnection

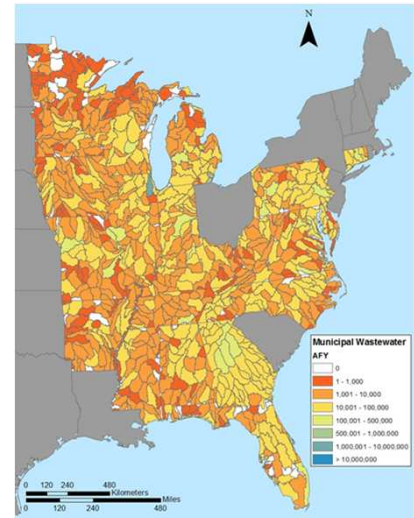
Fresh Surface Water



Fresh Groundwater



Municipal Wastewater



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

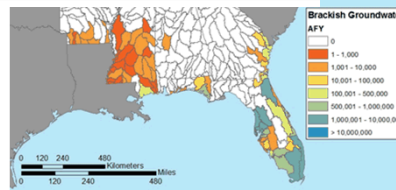
March 16, 2016
[New Energy Infrastructure and Related Data](#)
The following energy infrastructure layers, and related themes, have been added to the...

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

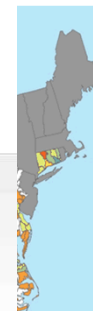
March 01, 2016

Partners and Sponsors

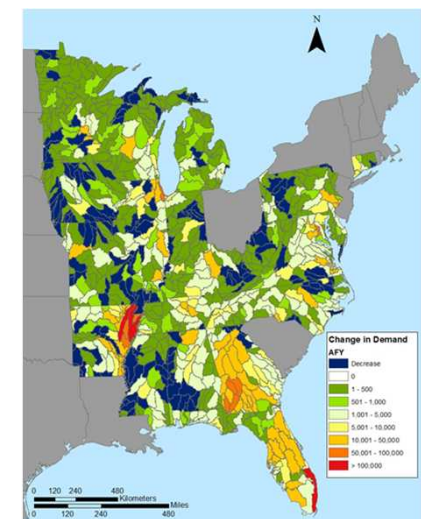
The study is led by the Eastern Interconnection States' Planning Council (EISPC). The research support and technical assistance to EISPC is provided by Argonne National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory. Funding is provided by the U.S. Department of Energy.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



water



Consumptive Demand 2010-2030



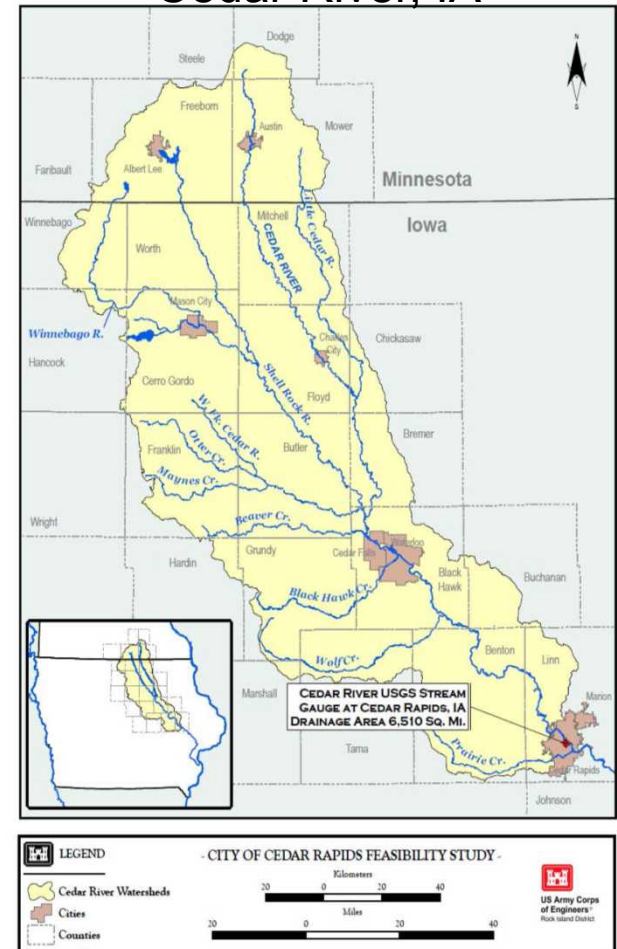
Electricity-Water-Climate Nexus

- How will climate variability impact operations of electric power systems:
 - Electricity demands,
 - Water deliveries,
 - Hydropower production, and
 - Extreme events?

San Juan River, NM

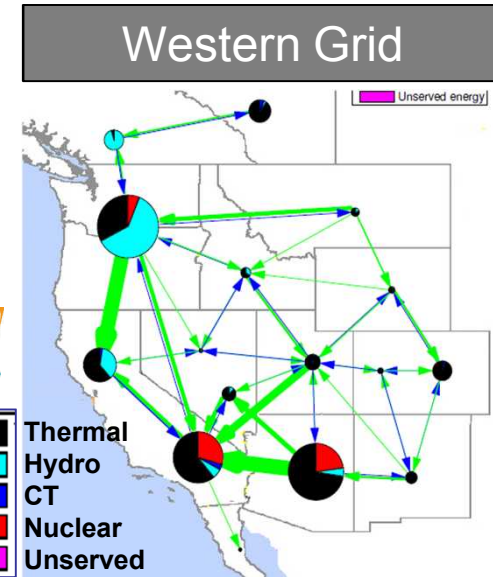
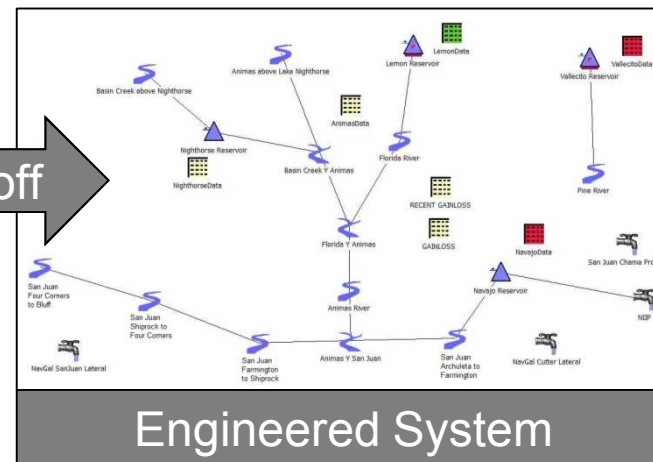
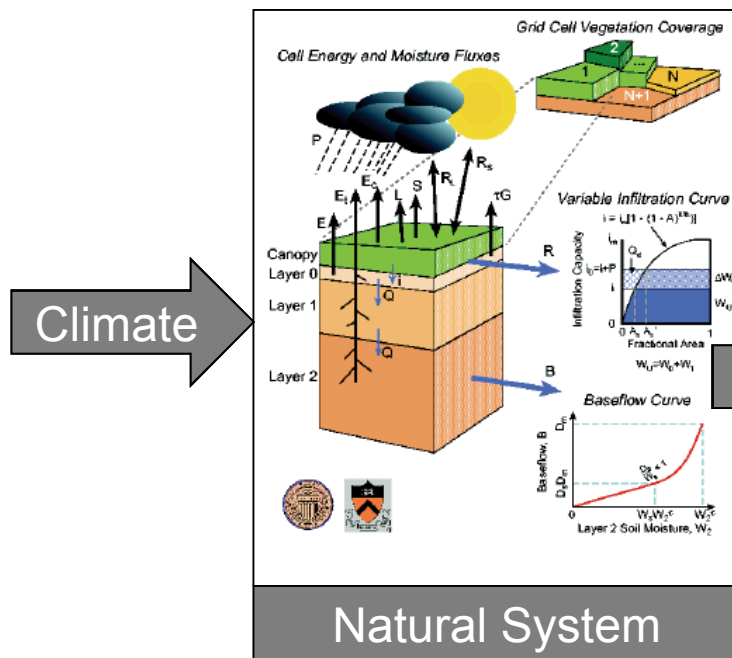


Cedar River, IA



Electricity-Water-Climate Nexus

- Framework that links natural and engineered systems to evaluate climate vulnerabilities:
 - Multiple interdependent systems,
 - Multiple interacting scales, and
 - Multiple stakeholders.



Deliveries

- Electric Power
- Irrigation
- Instream Flows
- Compact Native American

■ Project data available at:
http://energy.sandia.gov/?page_id=1741

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The screenshot shows the Sandia National Laboratories website. The header includes the Sandia logo and navigation links for Energy and Climate, Renewable Systems, Climate/Environment, Energy Infrastructure, Energy Research, and About EC. The main content area is titled 'Energy and Water in the Western and Texas Interconnects'. It features a background image of a power plant and wind turbines. The text discusses the impact of energy on water resources, noting that the energy sector accounts for approximately 41% of daily fresh water withdrawals and 49% of total overall daily water withdrawals. It lists several energy-related uses: hydroelectric power generation, thermoelectric power plant cooling and air emissions control, and energy-resource extraction, refining, and processing. A sidebar on the right contains links to the Water Security Program and the Energy-Water Data Portal. The page is tagged with various keywords and includes social media sharing options.

The footer of the Sandia National Laboratories website. It features the tagline 'Exceptional service in the national interest'. Below this, there are five columns of links and information: EC (About Energy and Climate (EC), Energy Security, Climate Security, Infrastructure Security, Energy Research, Key Facilities, Partnerships), EC Highlights (Sandia Report Presents Analysis of Glac Impacts of Vernalis Solar Power Site, Sandia Wins Award for Best Paper at IEEE Photovoltaic Specialist Conference (PVSC), Sandia Completes Hydrostructural Analysis of Coastal Renewable Power Company's TIGER® Turbine, The Influence of Solar Blade Design on Wake Development), EC Top Publications (Solar Energy Grid Integration Systems: Final Report of the Florida Solar Energy Center Team, Modeling System Losses in PVarray, Improved Test Method to Verify the Power Rating of a Photovoltaic (PV) Project), Related Topics (Concentrating Solar Power, CSP EPRC Energy, Energy Efficiency Energy, Security Infrastructure, Infrastructure Security National, Solar Thermal Test Facility, NSTTF photovoltaic, Photovoltaics PV, Renewable Energy solar Solar, Energy solar power Solar, Research Solid-State, Lighting SSLs), and Connect (Contact Us, RSS, Google+, Twitter, Facebook, LinkedIn, YouTube, Flickr).