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## Integrating Water in Electric Transmission Planning

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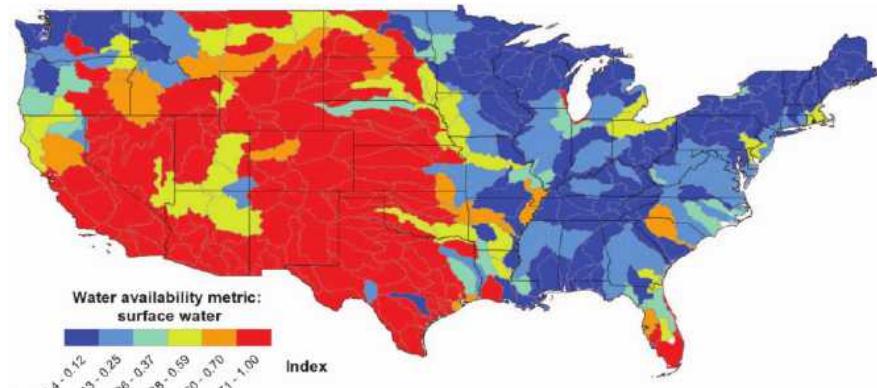


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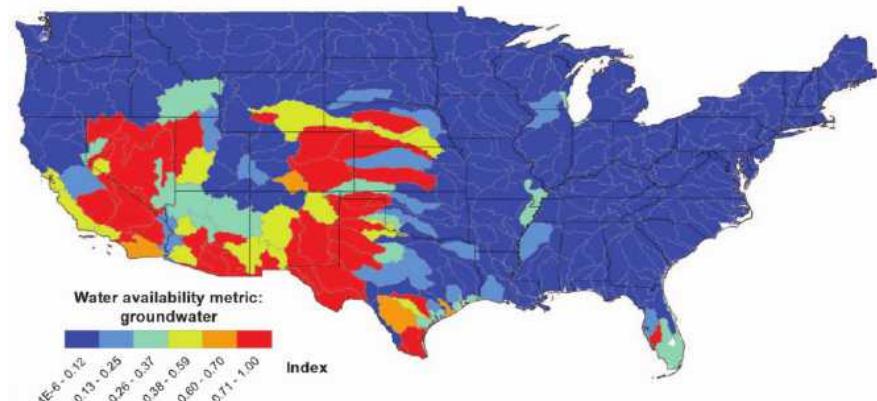
# The Challenge

- 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

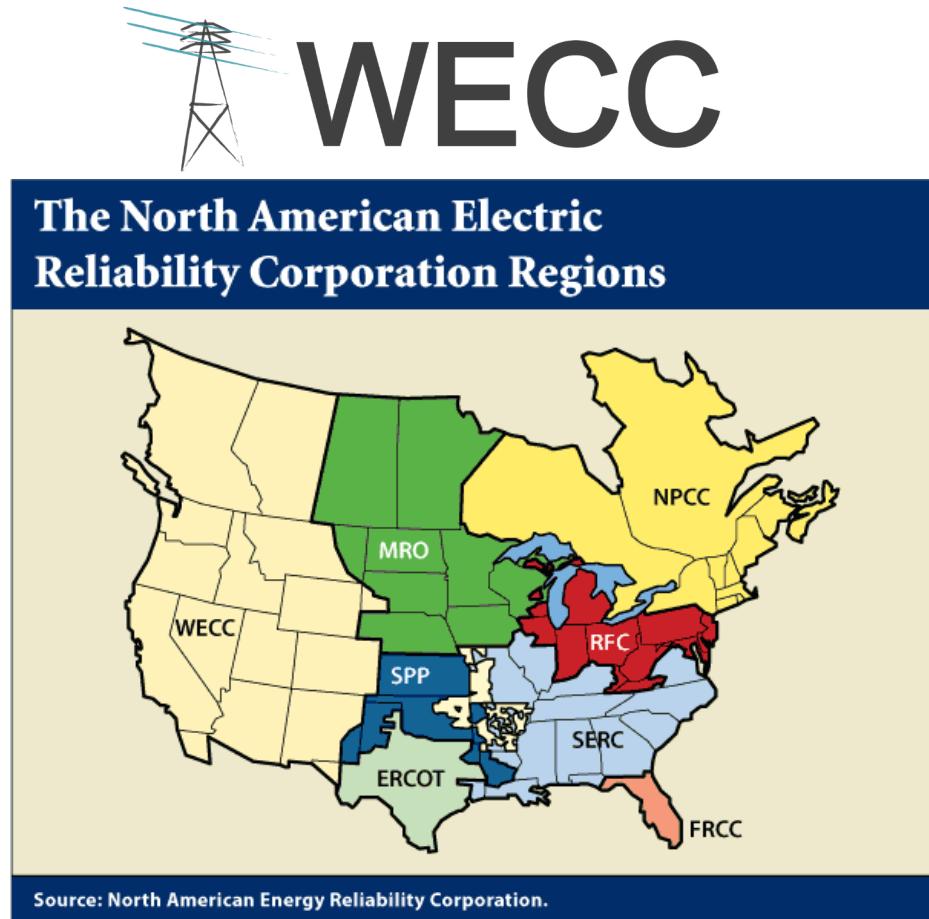


Groundwater Availability



# Objective

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



**WESTERN  
GOVERNORS'  
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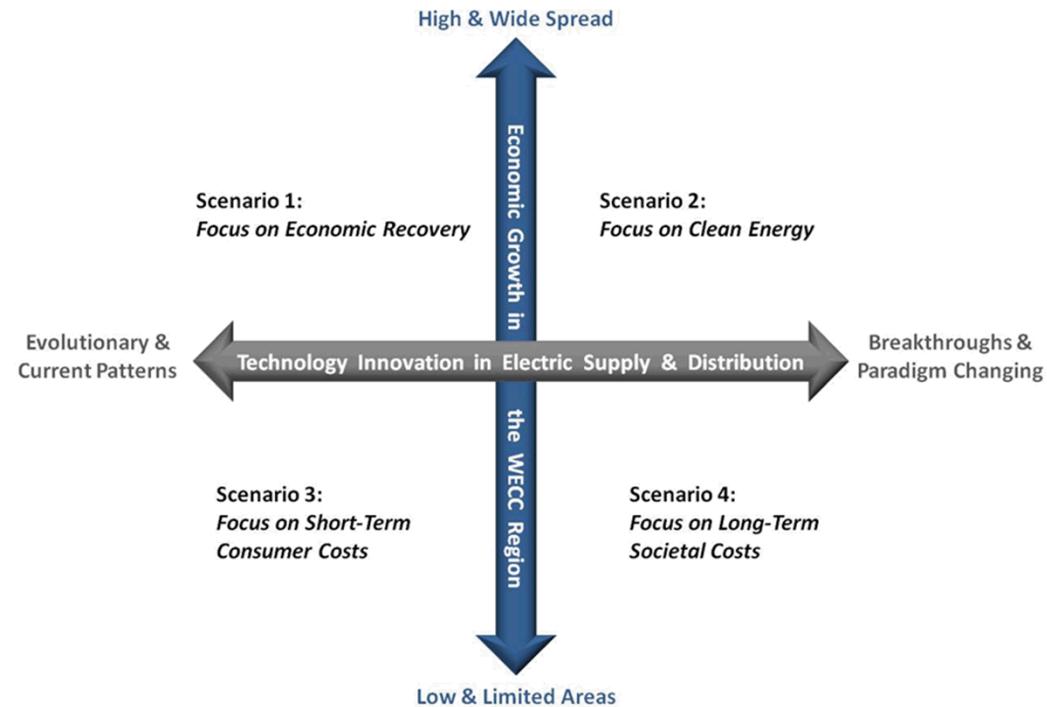


**WSWC**

**Western States Water Council**

# Methods: Scenario Development

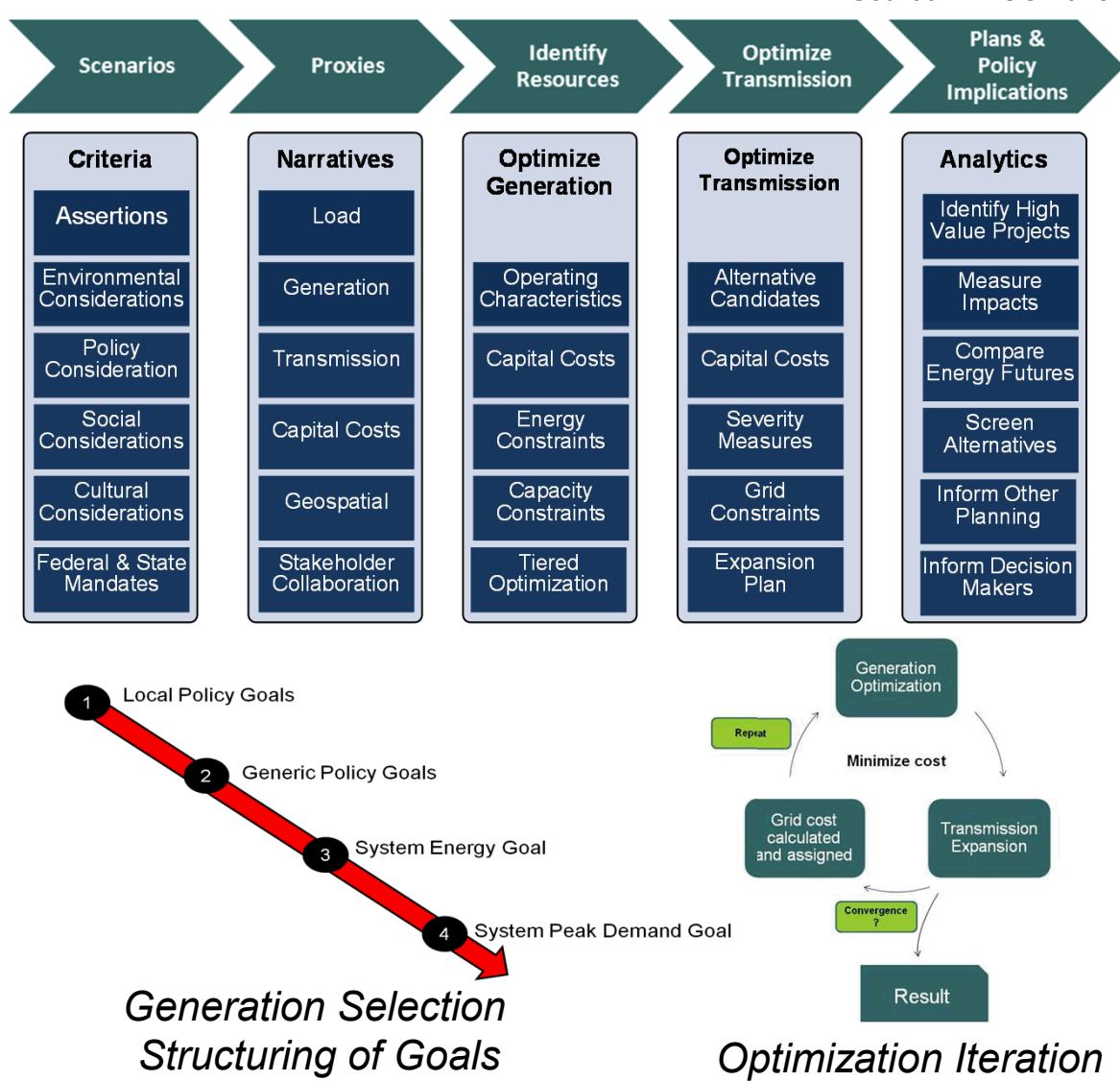
- **Reference Case:** adopted trajectory of recent WECC planning information.
- **Scenario One:** favored continued trends in growing use of natural gas and renewables.
- **Scenario Two:** distinct shift toward renewables, energy efficiency and significant carbon tax.
- **Scenario Three:** reliance on 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

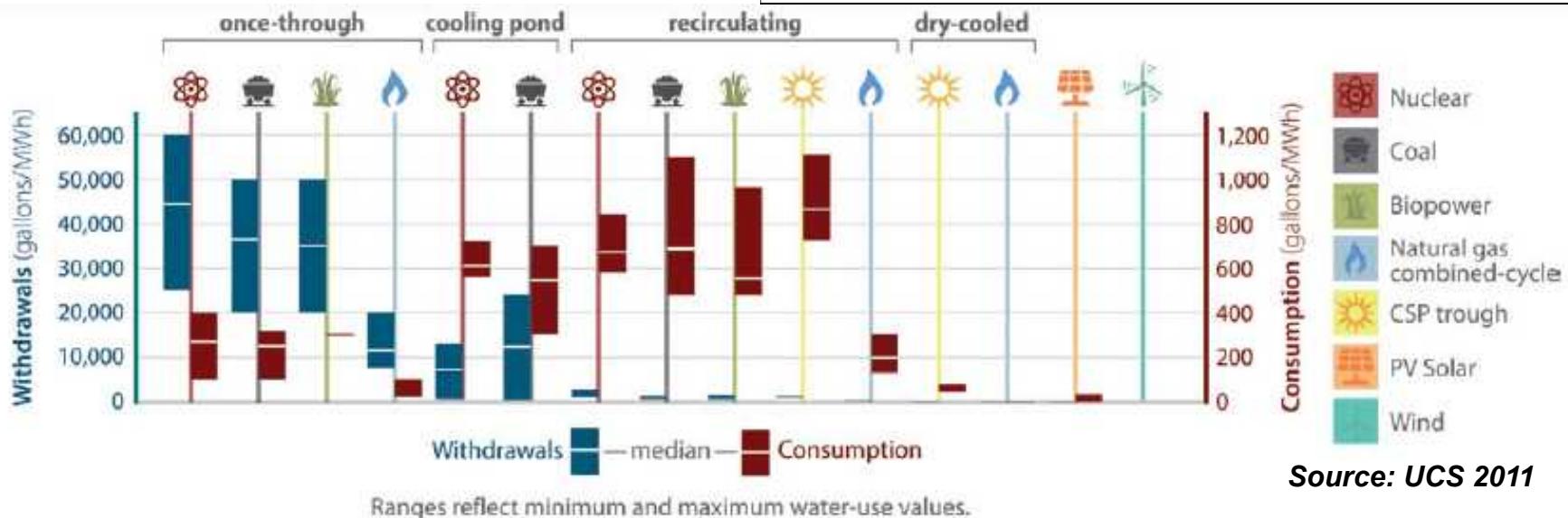
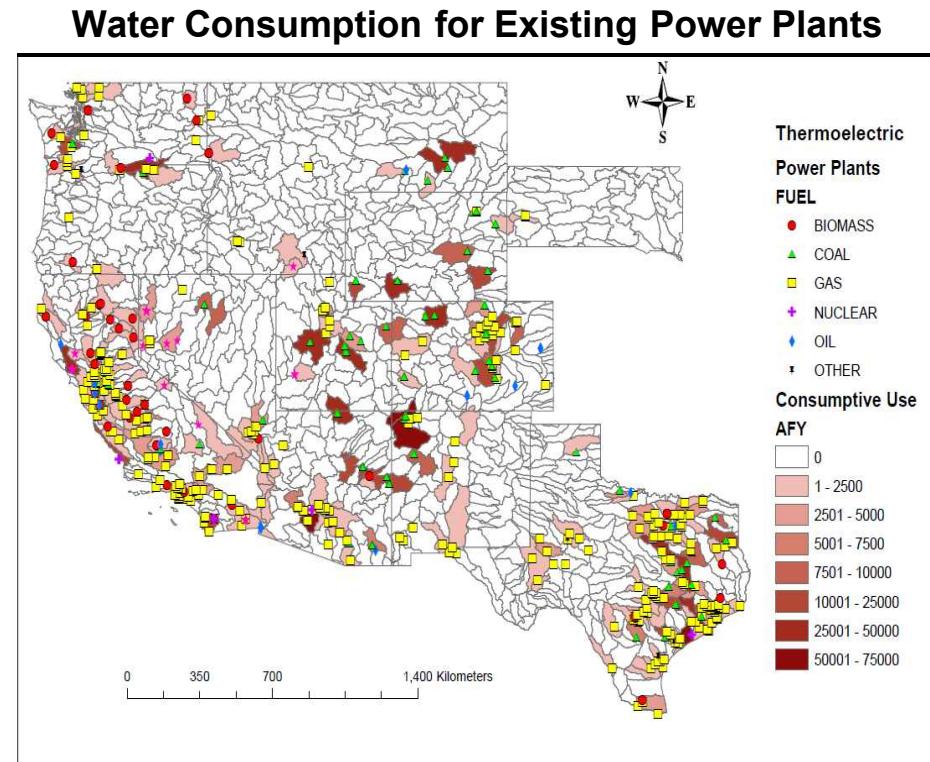
# Methods: Capital Cost Expansion Tool

- 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.



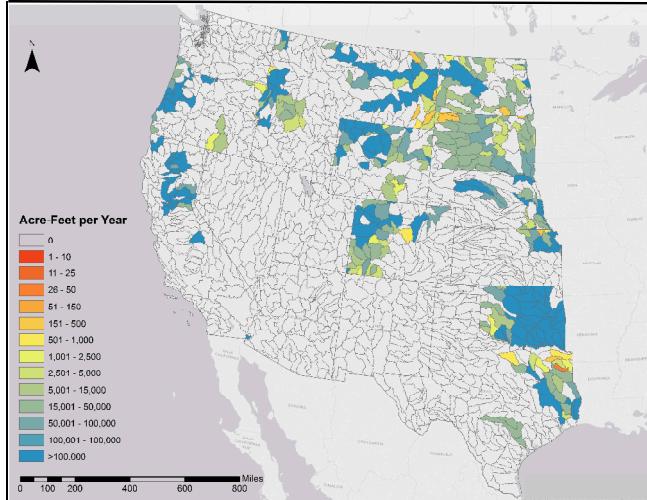
# Methods: Water for Thermoelectric Power

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

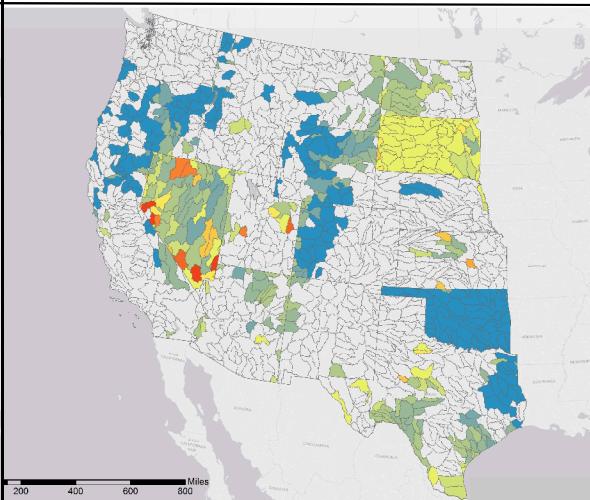


# Methods: Water Supply Availability

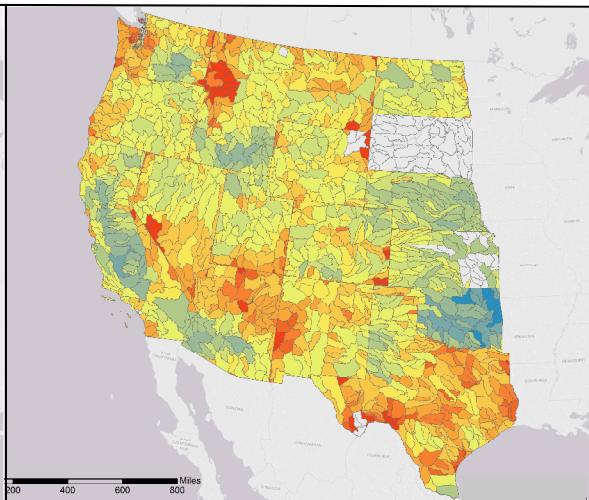
Unappropriated Surface Water



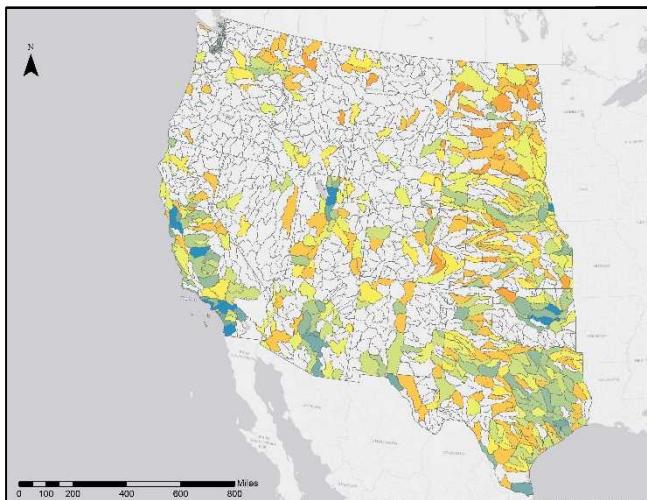
Unappropriated Groundwater



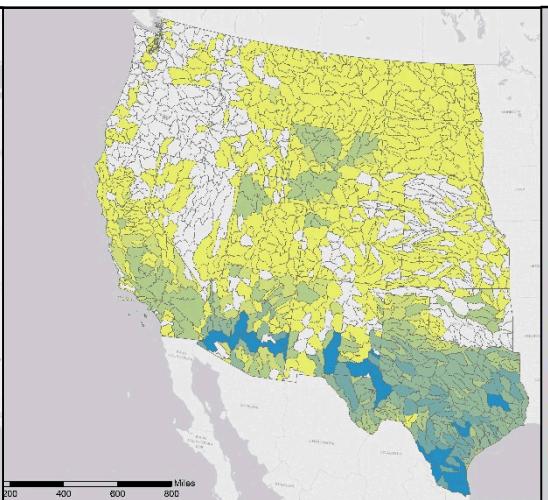
Appropriated Water



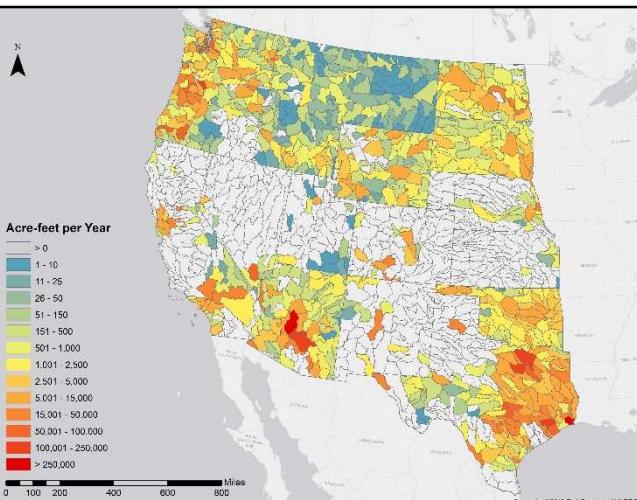
Municipal Wastewater



Brackish Groundwater



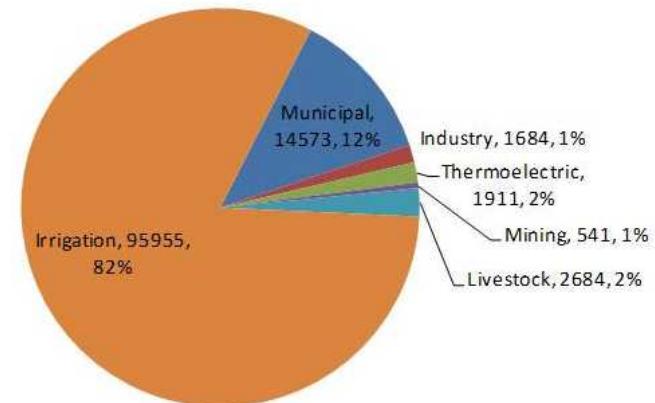
Consumptive Demand 2010-2030



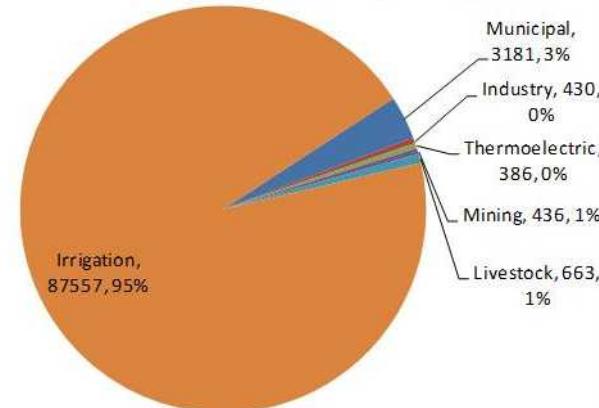
# Results: Understanding Current Use

- 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*?

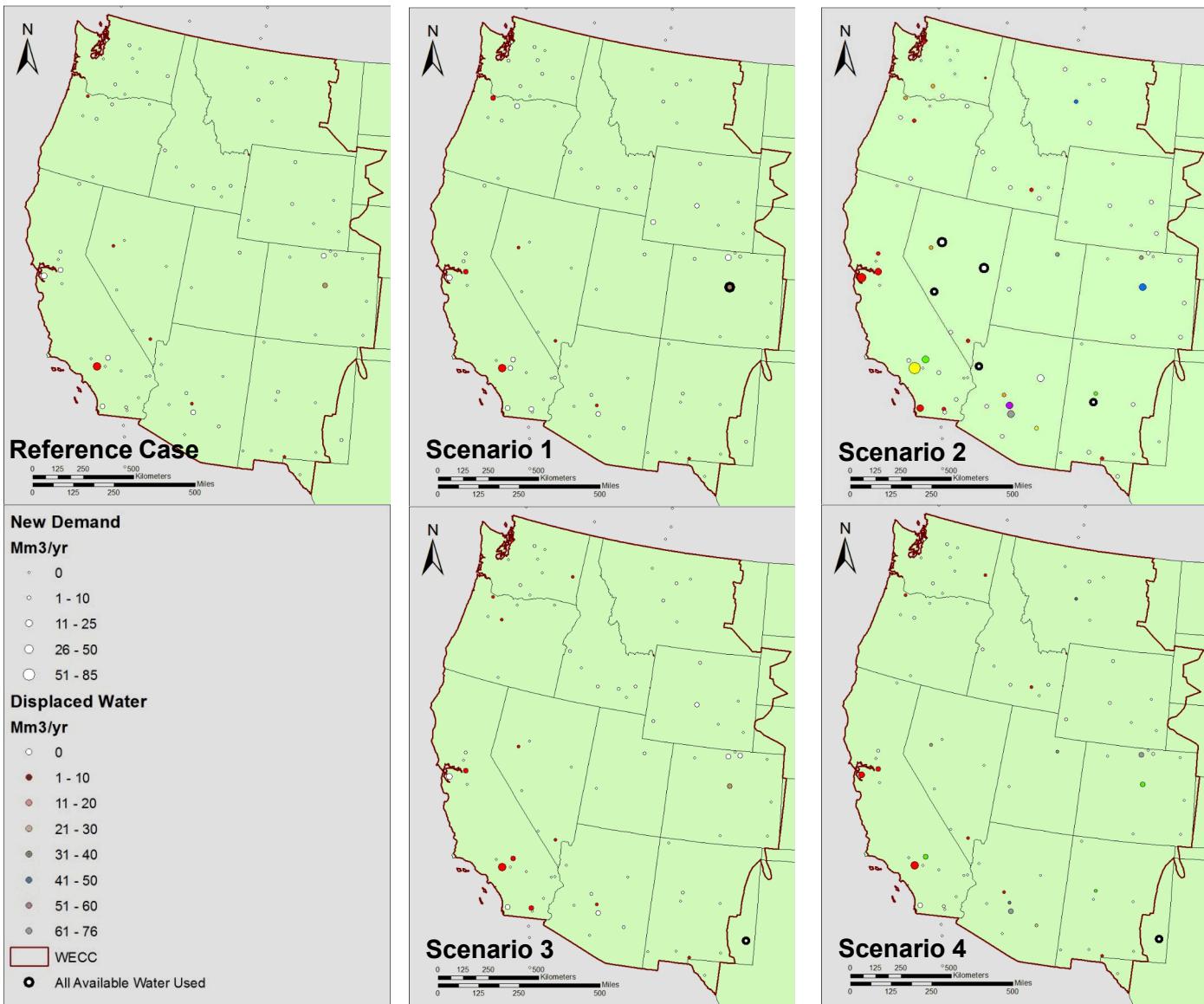
2010 Water Withdrawal (MGD)



2010 Water Consumption (MGD)

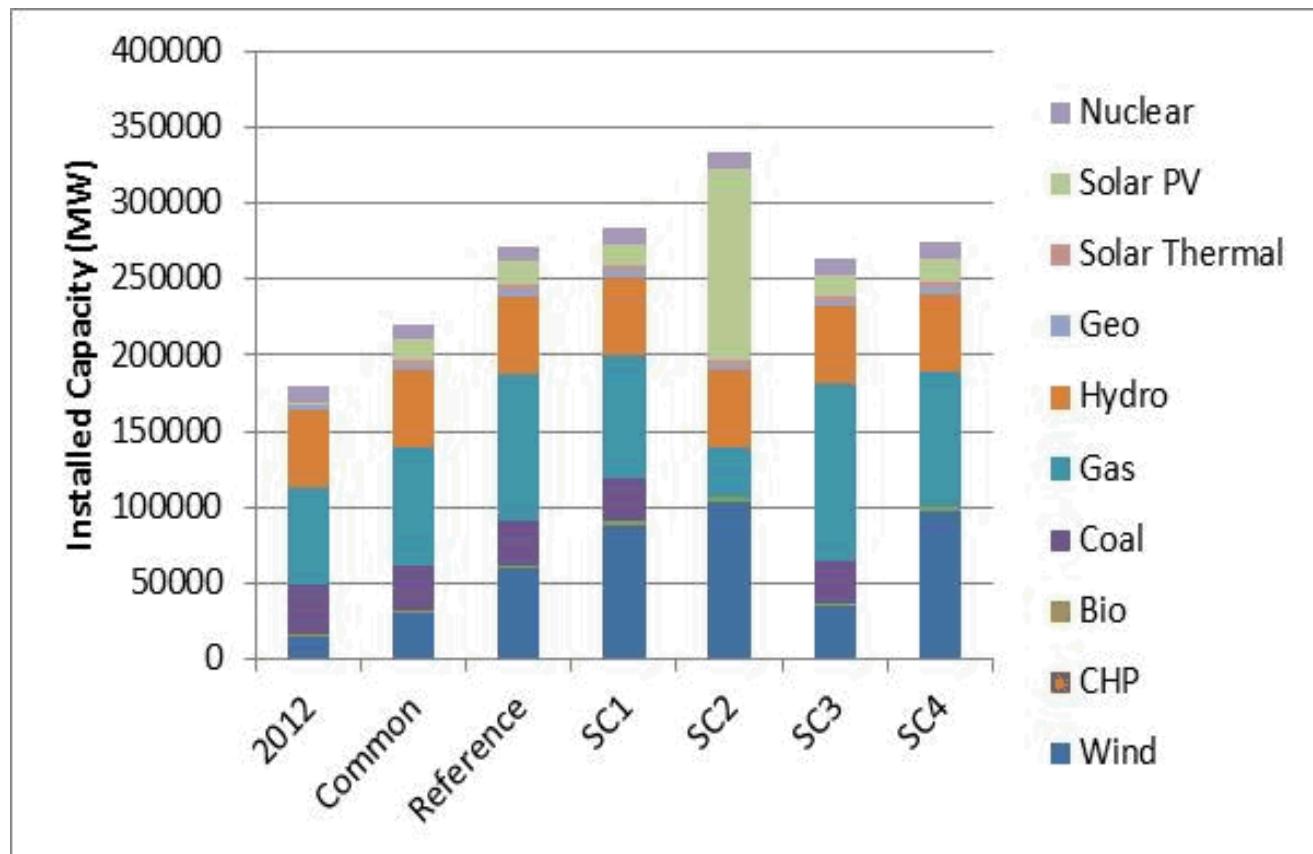


# Results: Water Constraint

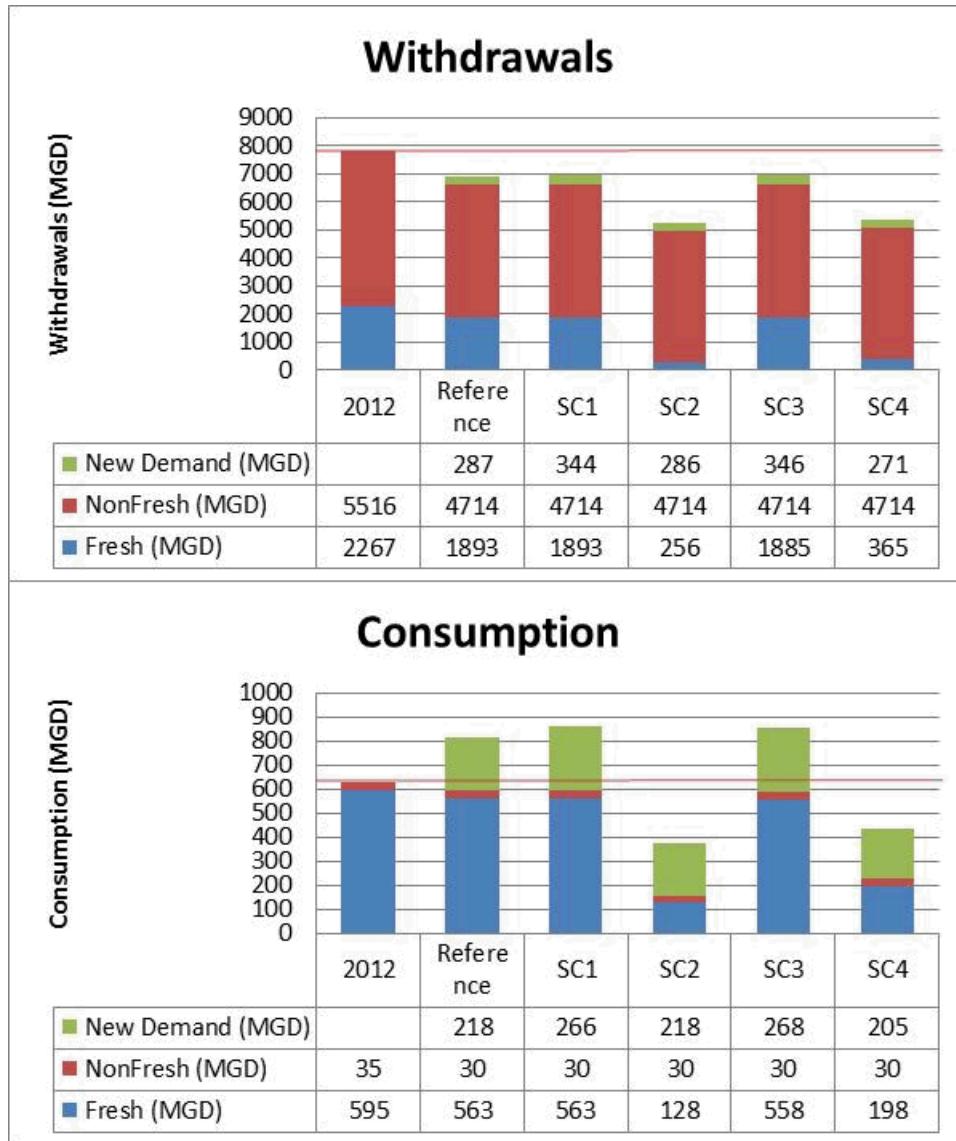


# Results: Generation Expansion

- 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.

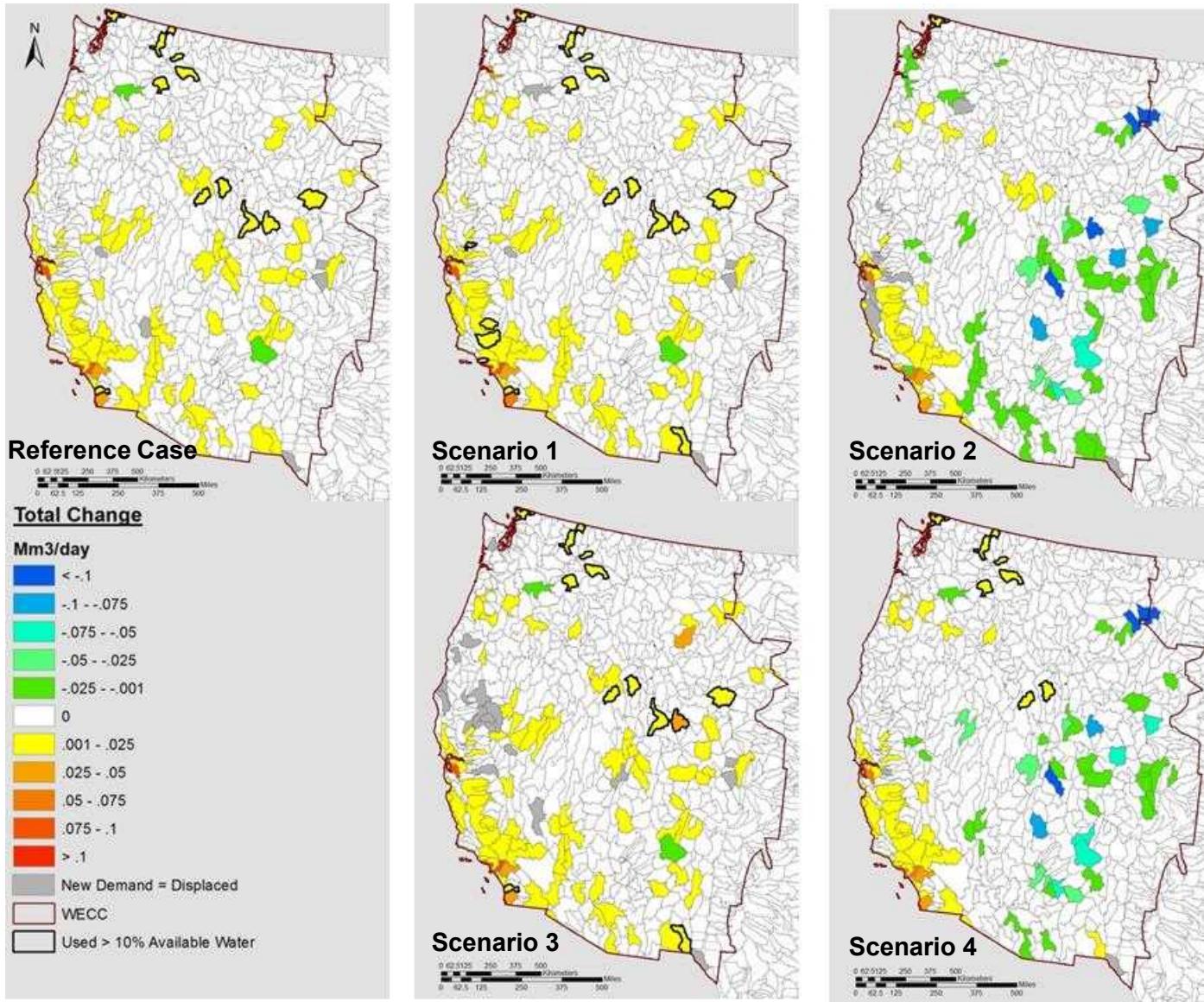


# Results: Water Use

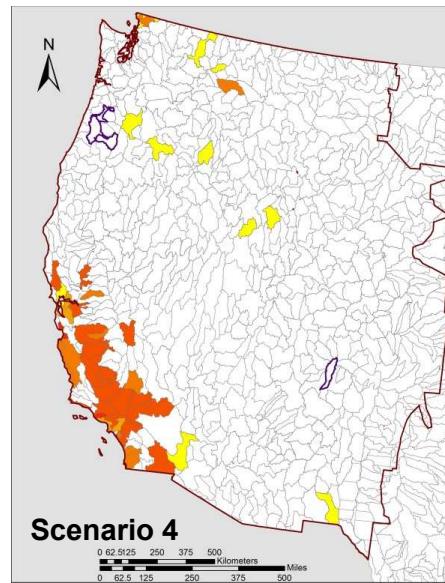
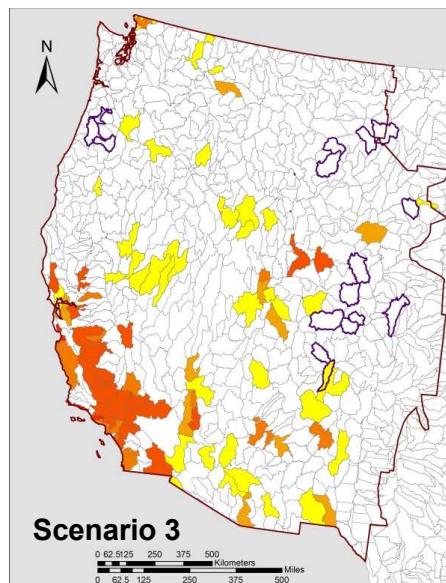
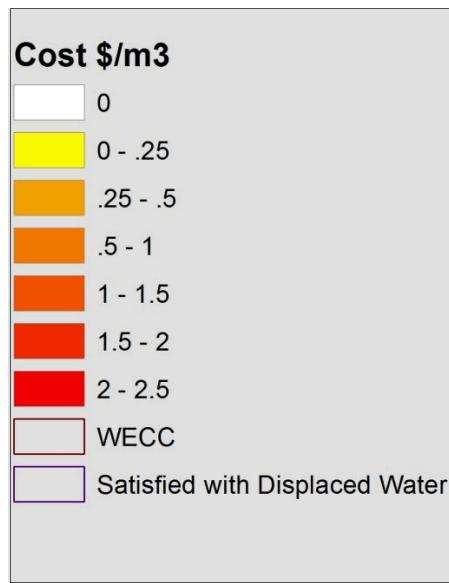
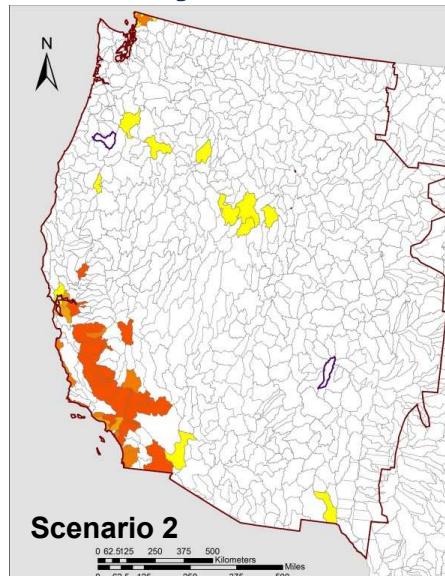
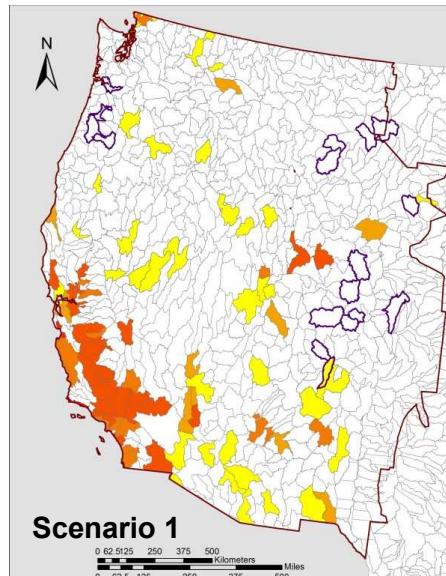
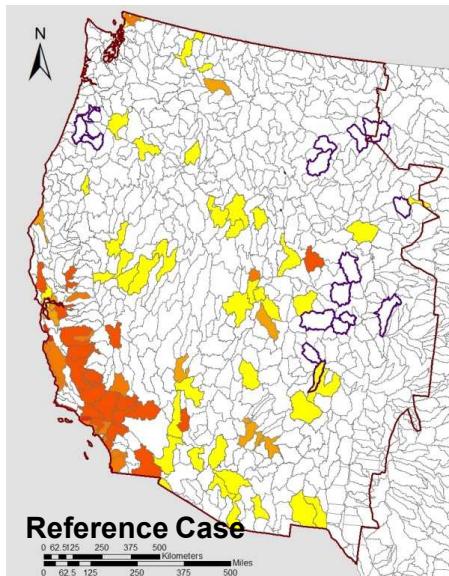


- Uniform reductions in withdrawals:
  - Similar additions across scenarios,
  - Retirements of 14% of seawater and 4 % freshwater withdrawals,
  - >70% displacement of freshwater withdrawal in scenarios 2 and 4
- Consumption varies by scenario:
  - Uniform additions,
  - >30% decrease for scenarios 2 and 4 (displaced coal)
  - >30% increase for other scenarios

# Results: Watershed Supply Analysis



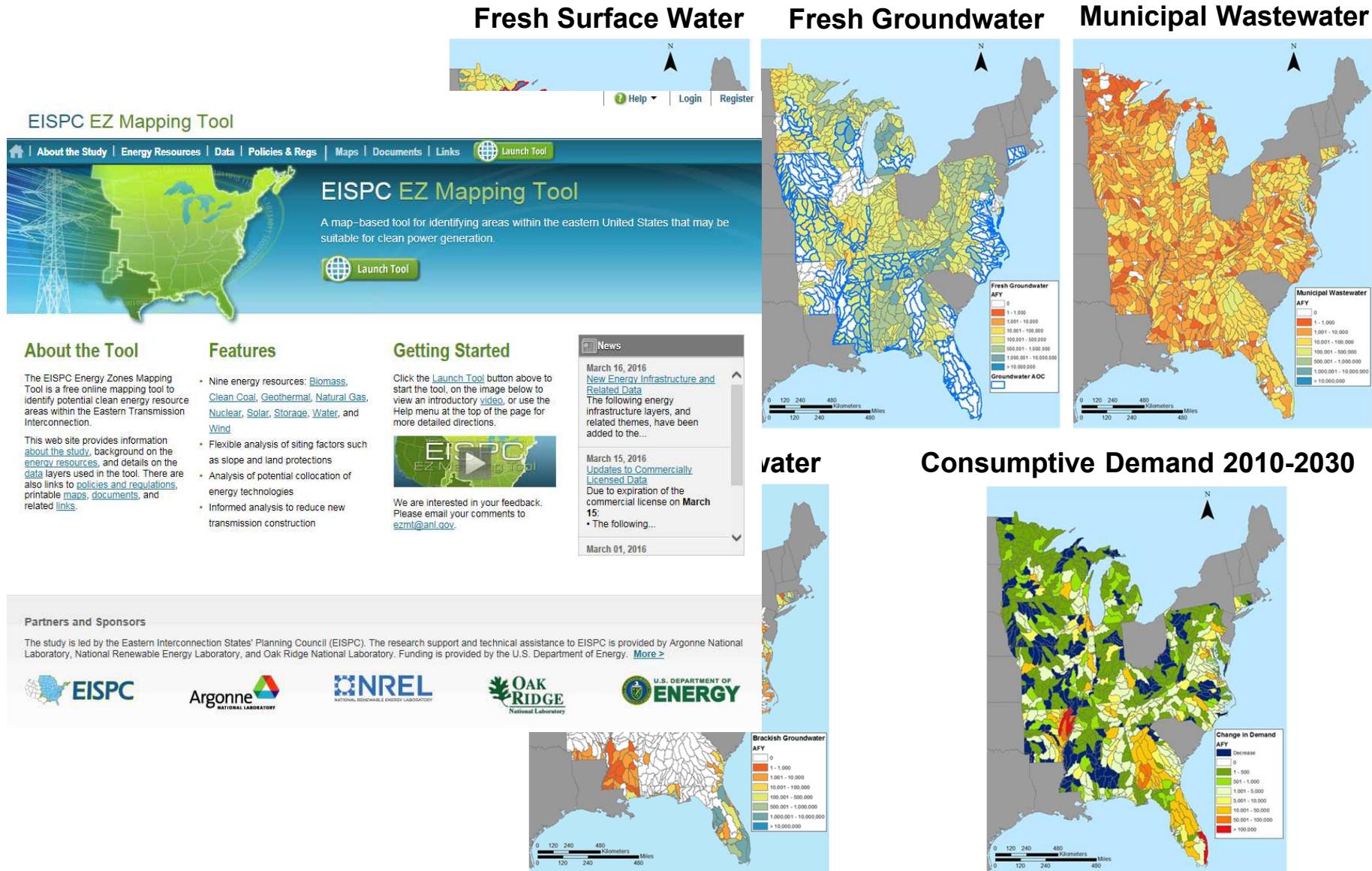
# Results: Watershed Cost Analysis



# Takeaways

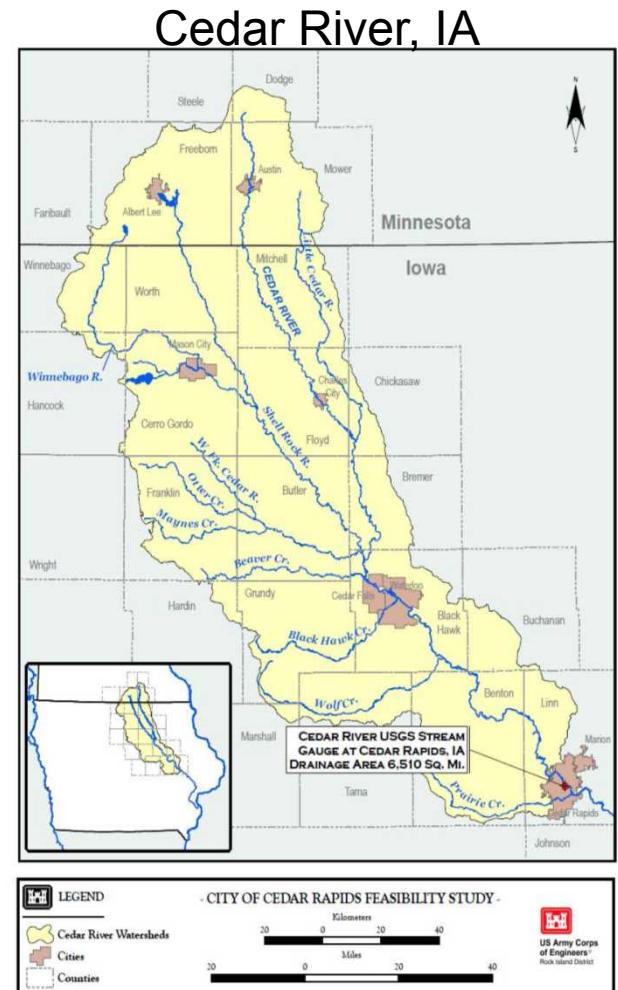
- Time and effort required to begin to “speak the same language.”
- Factors indirectly related to water (e.g., technology cost, energy policy) had greatest influence on future thermoelectric water use.
- Big difference in water use across scenarios, 30+% increase to a 30+% decrease in water consumption.
- 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



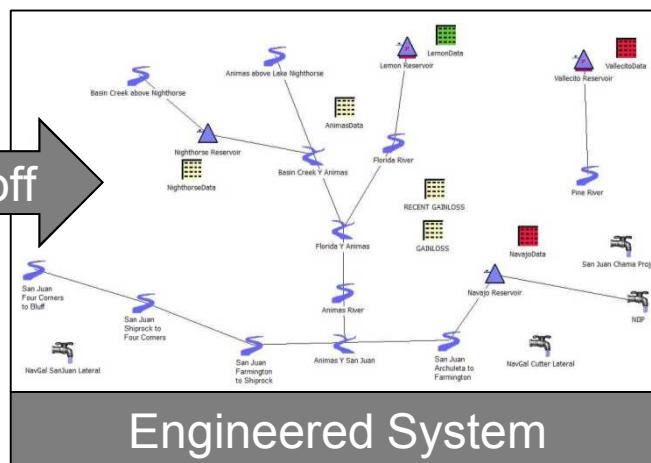
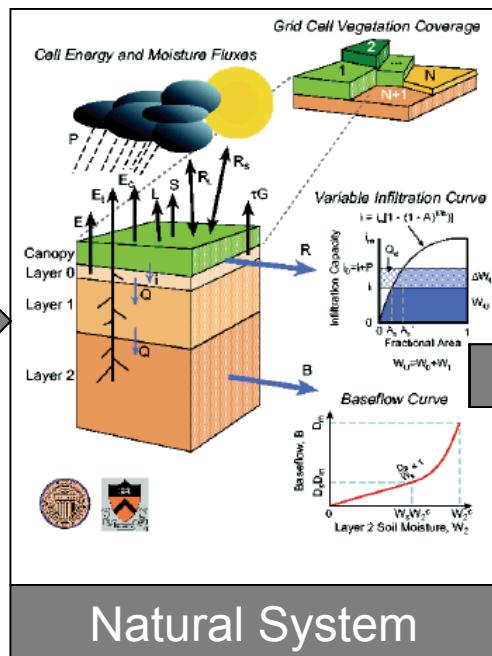
# Electricity-Water-Climate Nexus

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



# 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](http://energy.sandia.gov/?page_id=1741)

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Energy and Climate

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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

Background Objectives Tasks Benefits/Outcomes Collaborators Links Documents Data Portal

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

Tagged with: Air Emissions Control • ARRA • Climate • Climate Variability • Energy • Energy Resource Extraction • Energy Water Nexus • Environmental Vulnerabilities • ERCOT • Ground Water Supplies • Hydroelectric Power Generation • Office of Electricity • Recovery Act • SAND2013-1448W • Thermoelectric Consumptive Use • Thermoelectric Power • Water • Water Availability • Water Demand • water scarcity • Water Valuation • Watershed Model • Western and Texas Interconnects • Western United States

Last Updated: August 7, 2014

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

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