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Water as a Constraint on Transmission Expansion Planning

Vincent Tidwell and Barbie Moreland

Sandia National Laboratories

Michael Bailey

WECC

Katie Zemlick

Univ. of New Mexico

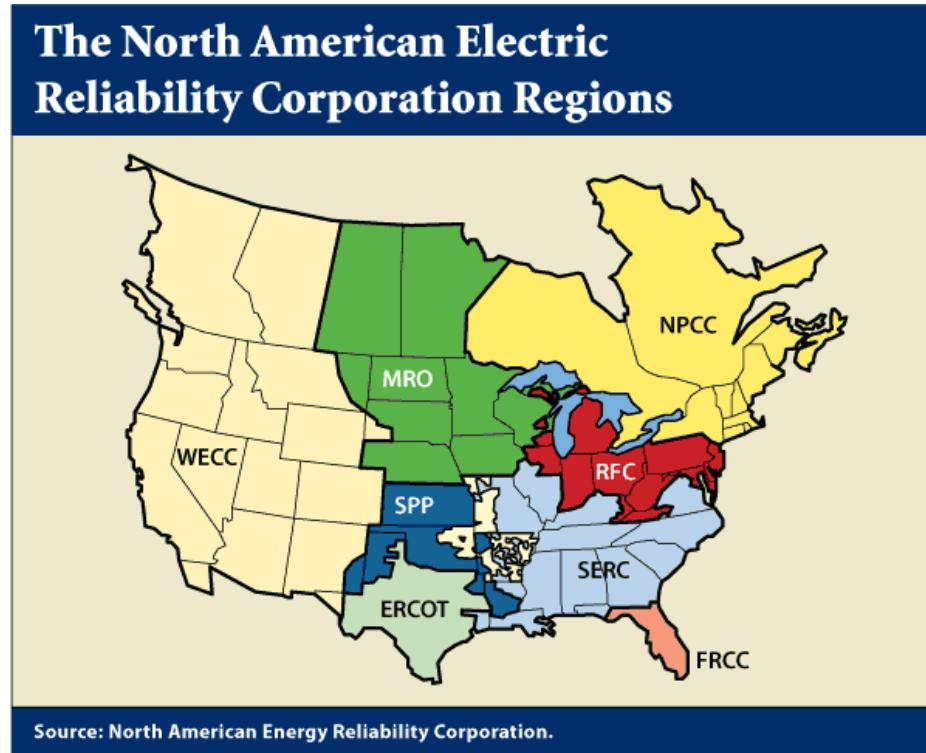
West Coast Climate Strategies Forum
San Diego, October 20, 2016



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Integrated Planning of Water and Energy

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



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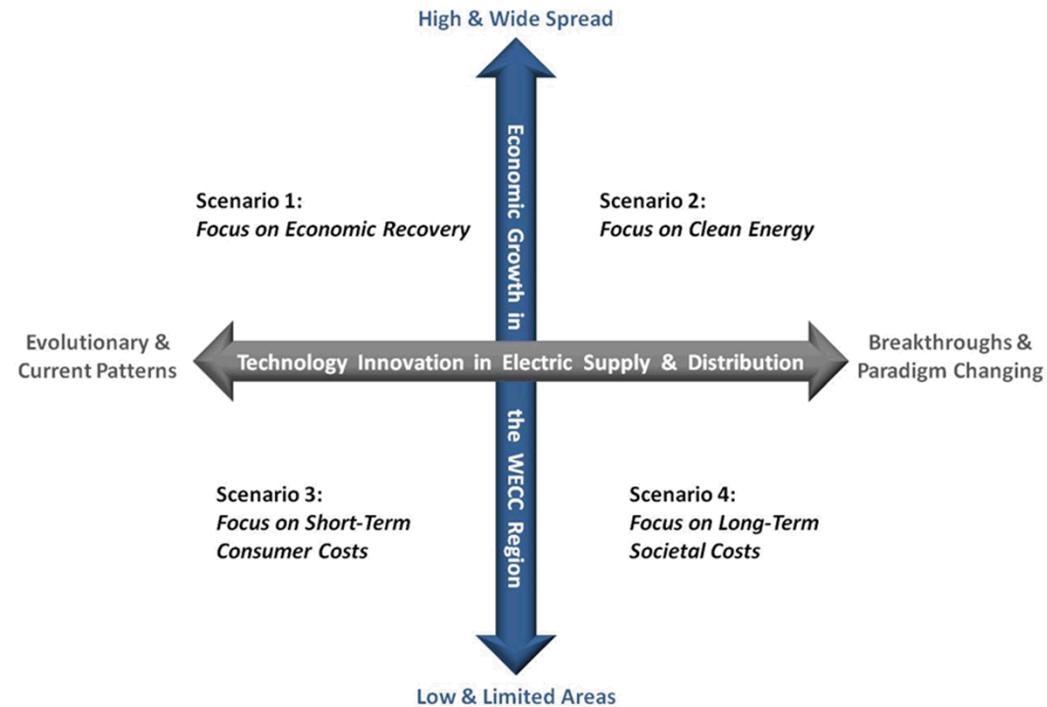
WECC



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.

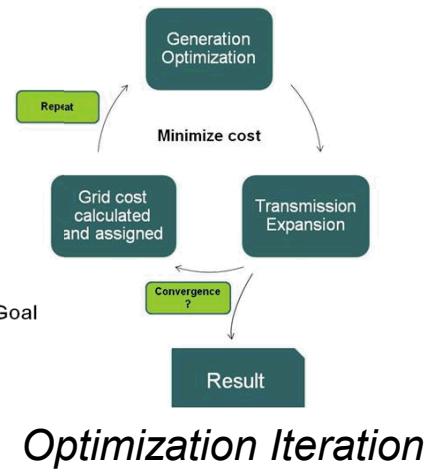
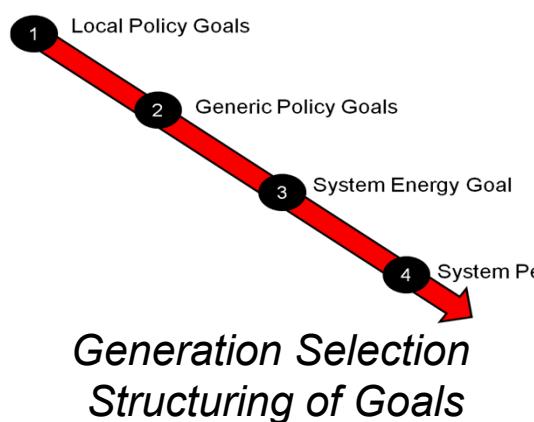
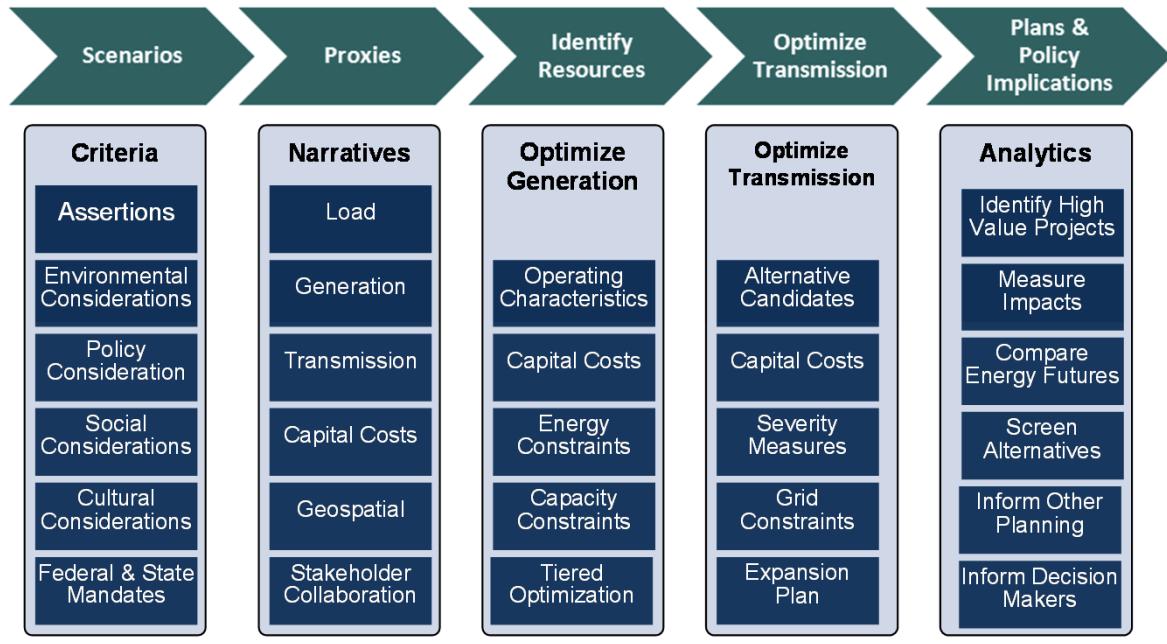


Source: WECC 2013

Methods: Capital Cost Expansion Tool

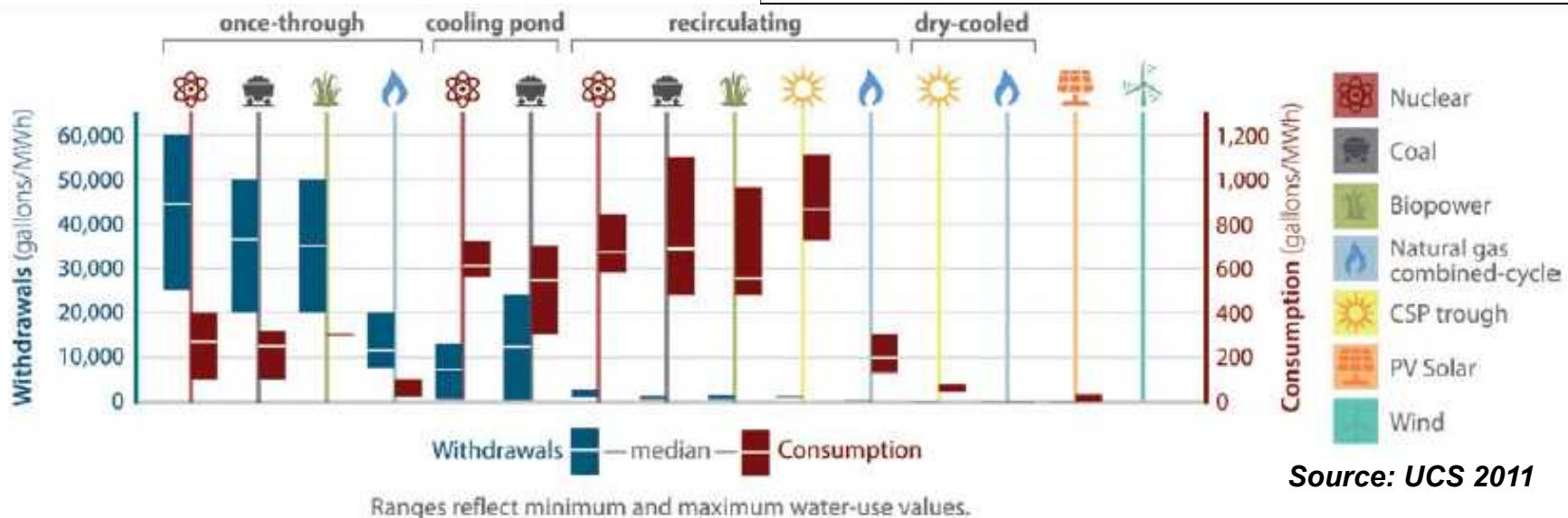
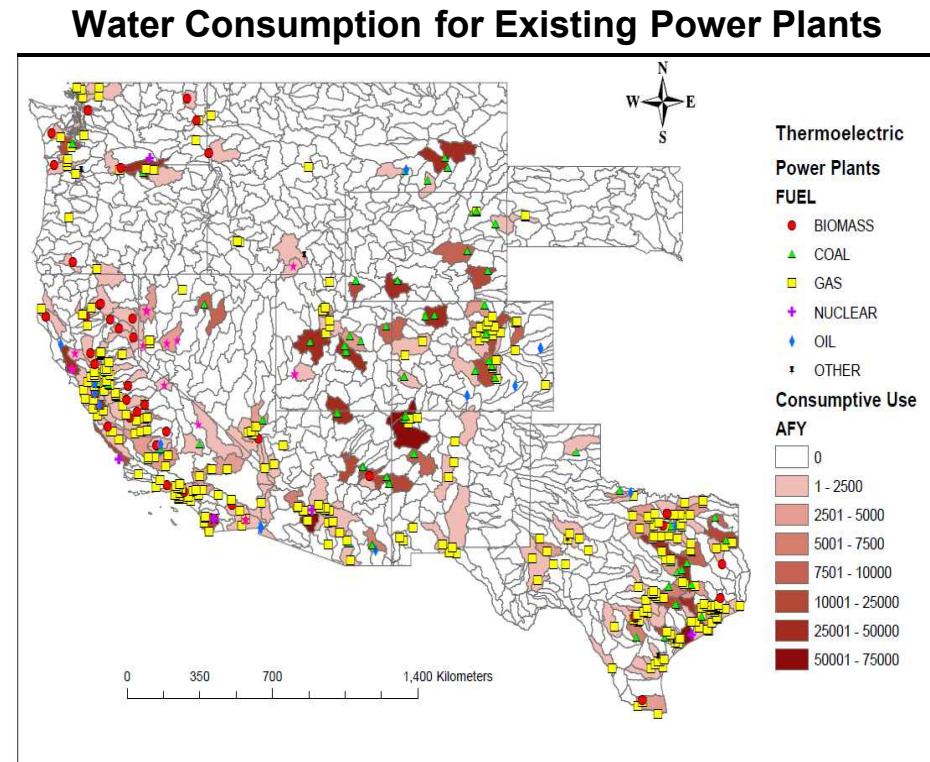
Source: WECC 2013

- 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.



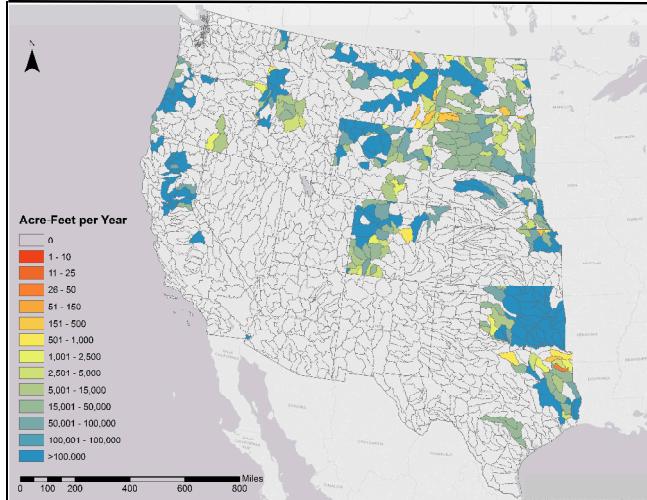
Methods: Water for Thermoelectric Power

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

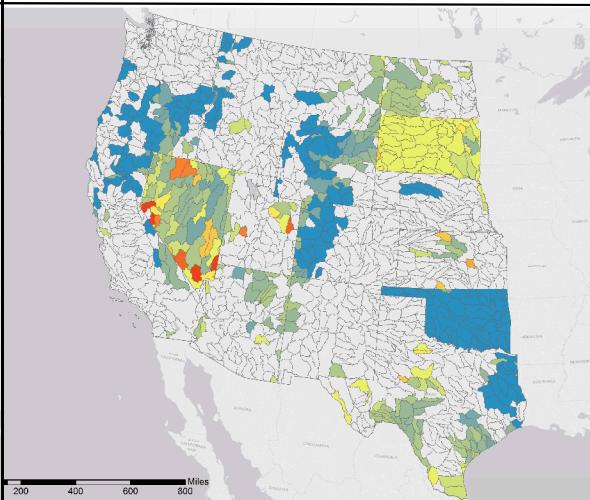


Methods: Water Supply Availability

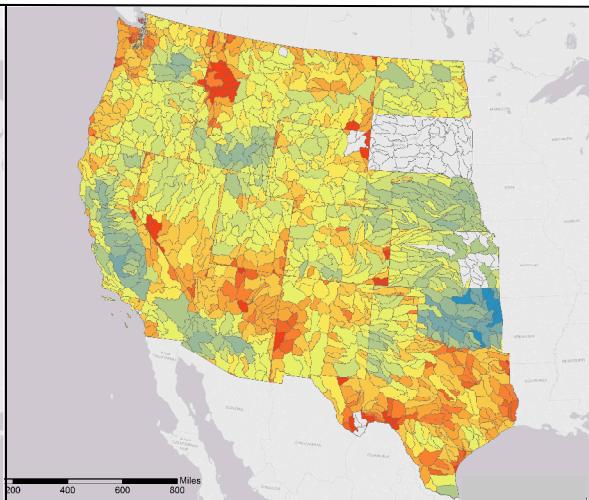
Unappropriated Surface Water



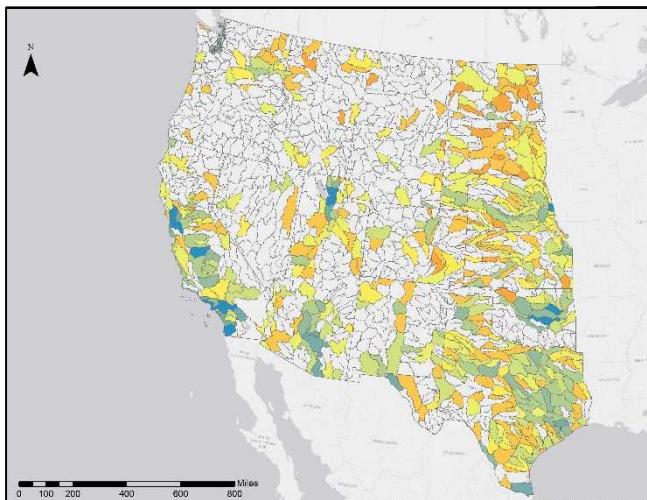
Unappropriated Groundwater



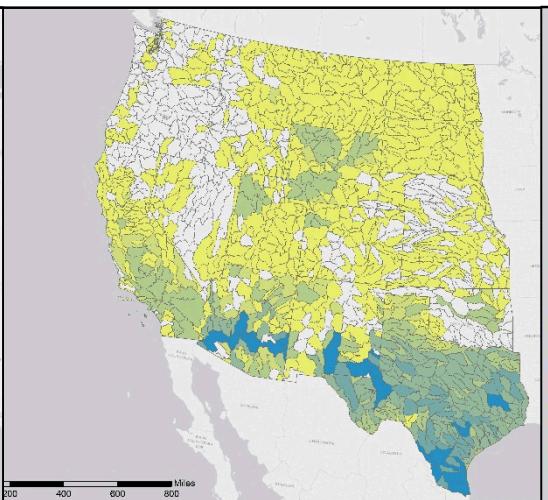
Appropriated Water



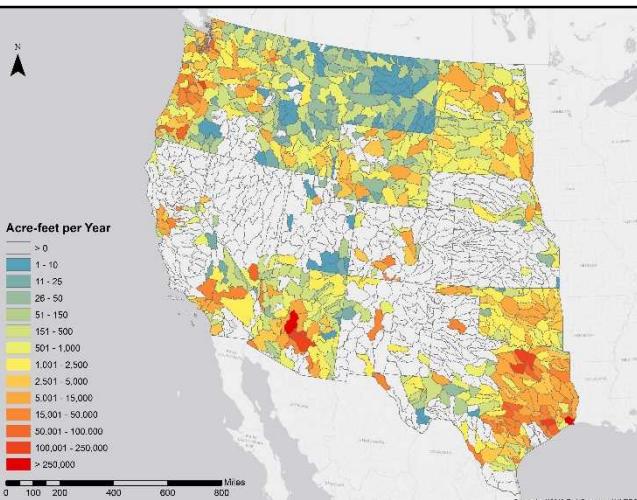
Municipal Wastewater



Brackish Groundwater

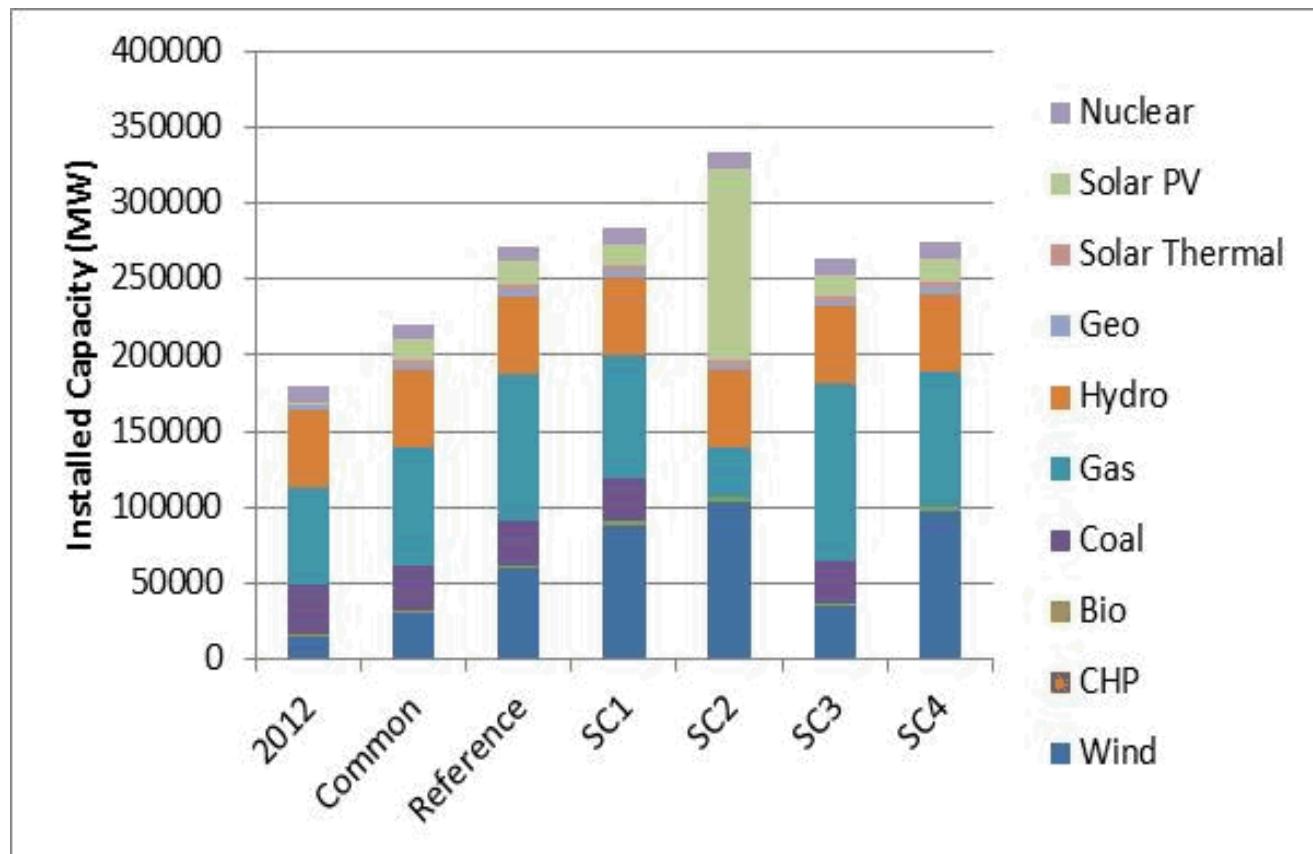


Consumptive Demand 2010-2030

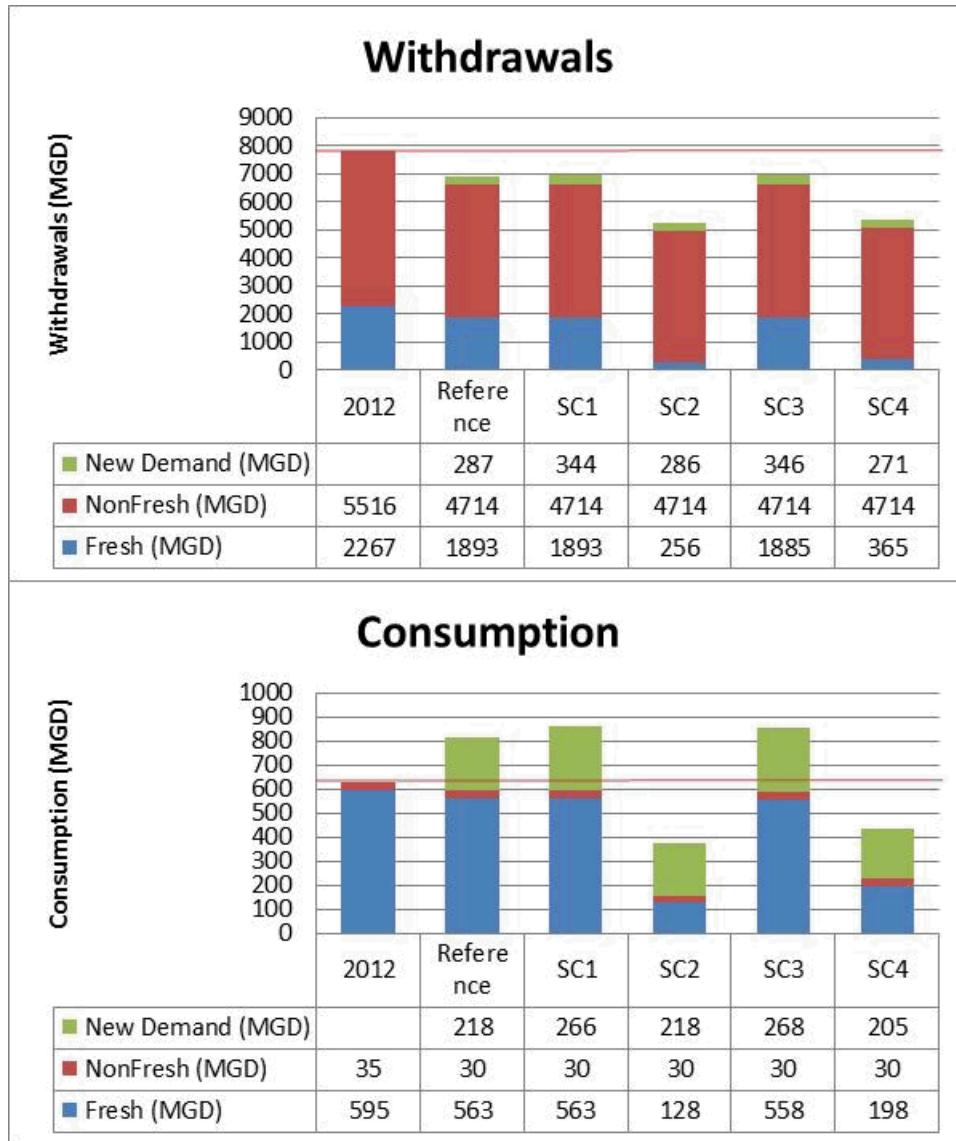


Results: Generation Expansion

- 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.

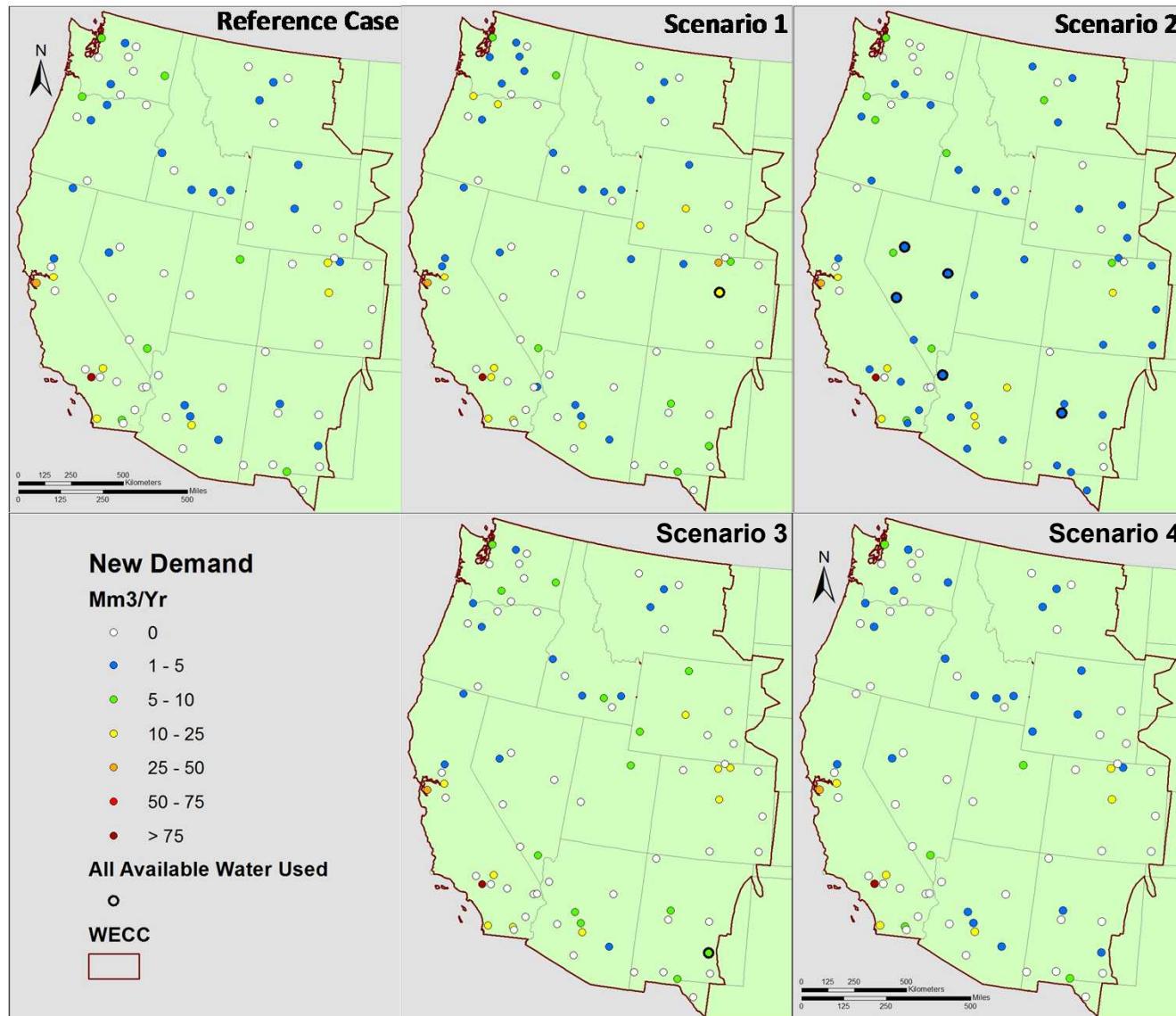


Results: Water Use

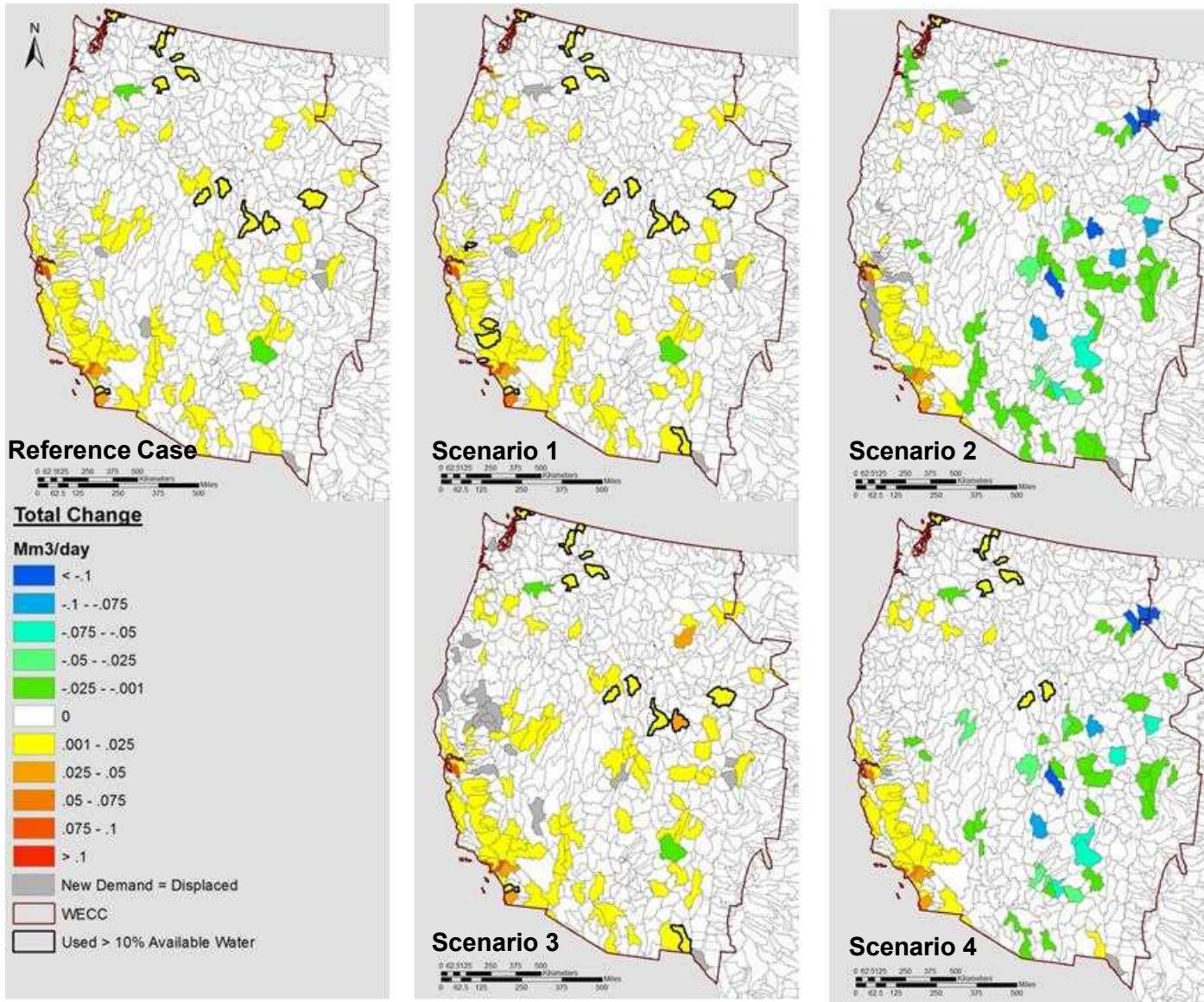


- Uniform reductions in withdrawals:
 - Similar additions across scenarios,
 - Retirements of 14% of seawater and 4 % freshwater withdrawals,
 - >70% displacement of freshwater withdrawal in scenarios 2 and 4
- Consumption varies by scenario:
 - Uniform additions,
 - >30% decrease for scenarios 2 and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

Results: Water Constraint



Results: Watershed Supply Analysis



Results: Importance of Alternative Water

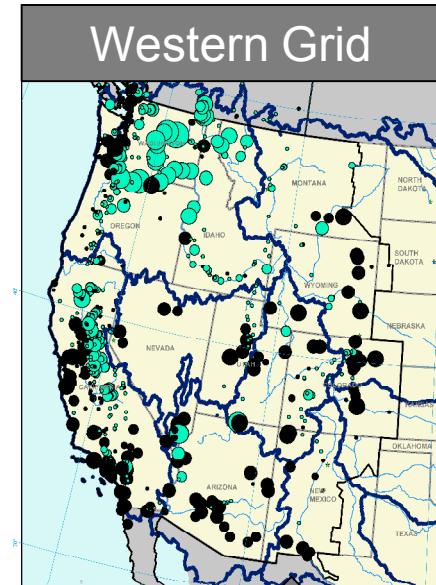
Scenario	Surface Water (%)	Groundwater (%)	Appropriated Water (%)	Wastewater (%)	Brackish Ground Water (%)
Reference Case	11	6	12	37	34
Scenario 1	16	6	10	35	33
Scenario 2	1	5	4	51	39
Scenario 3	16	7	12	31	34
Scenario 4	2	2	5	52	39

Takeaways

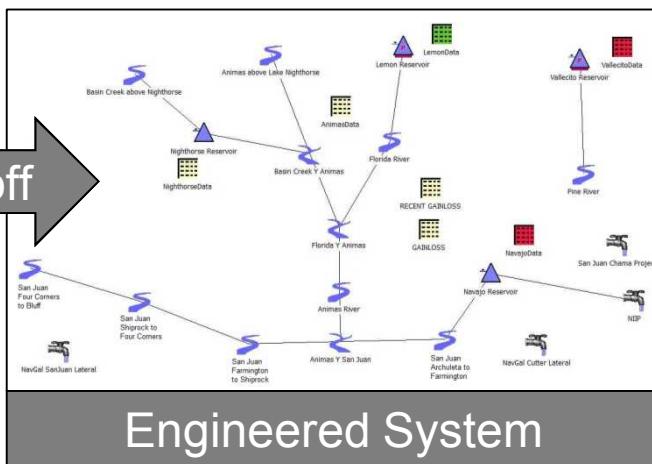
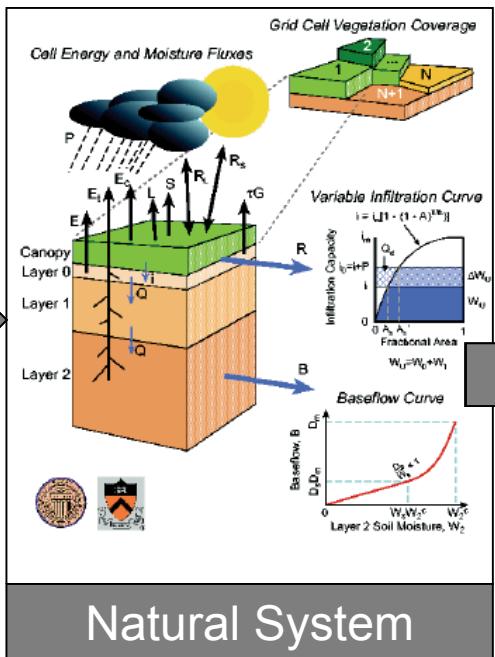
- Big difference in water footprint across scenarios, 30+% increase in consumption vs. 30+% decrease.
- Factors indirectly related to water (e.g., technology cost, energy policy) had greatest influence on water footprint.
- Thermoelectric expansion can occur with limited impact on water resources of the West.
- Expansion will likely require increased use of non-traditional waters.

Climate Vulnerability

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



Climate



- Project data available at:

http://energy.sandia.gov/?page_id=1741

Vincent Tidwell

Sandia National Laboratories

vctidwe@sandia.gov

(505)844-6025

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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
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ENERGY-WATER DATA PORTAL

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