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Multi-stakeholder Engagement Along the Water, Energy, Security Nexus

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Albuquerque, New Mexico

Stockholm International Water Institute

World Water Week Seminar

Stockholm, Sweeden

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NNSA National Nuclear Security Administration

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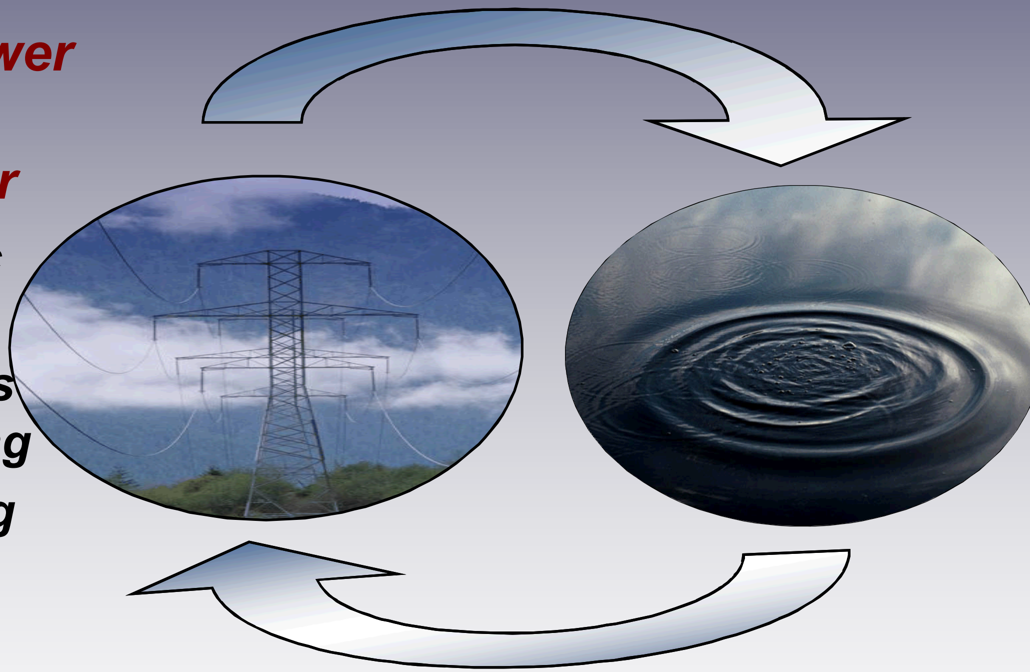
Water for Energy

Energy for Water

Energy and power production requires water

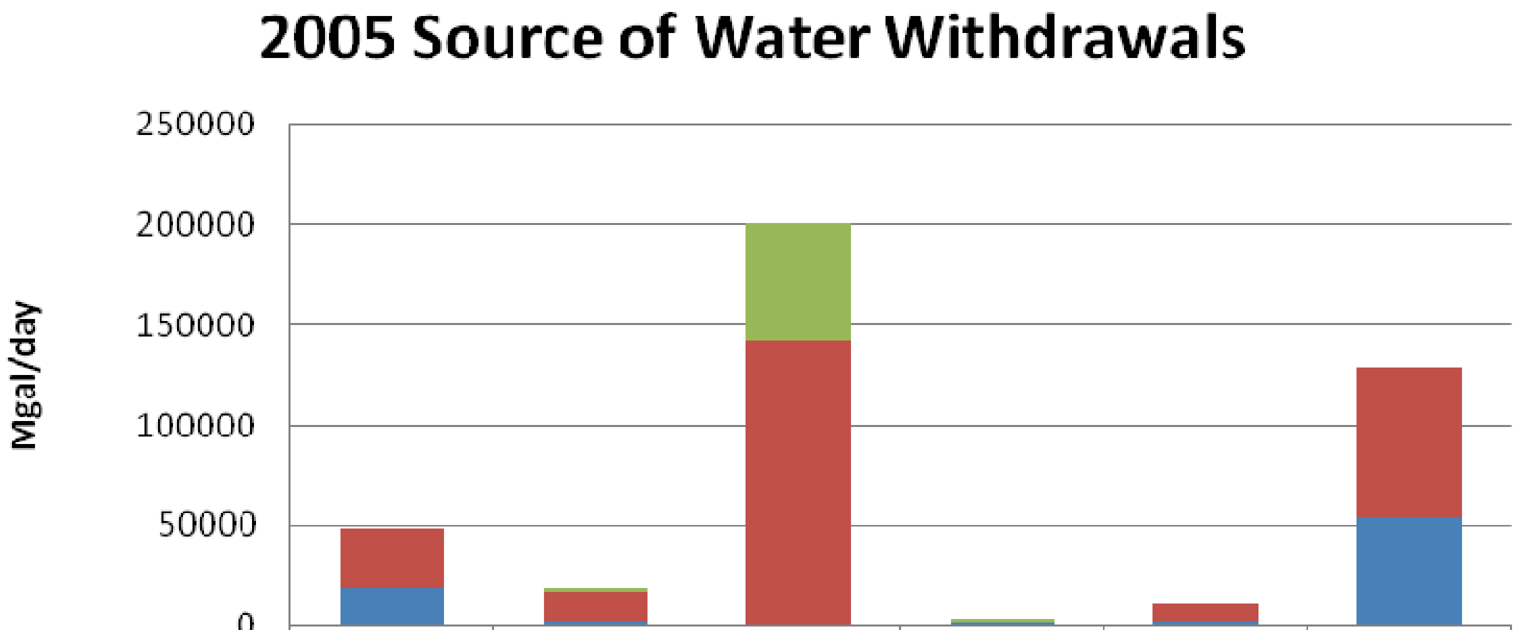
- ***Thermoelectric Cooling***
- ***Energy Minerals Extraction/Mining***
- ***Fuel Processing (fossil fuels, H_2,biofuels)***
- ***Emission Control***



Water production, processing, distribution, and end-use requires energy

- ***Pumping***
- ***Conveyance***
- ***Treatment***
- ***Distribution***
- ***Use Conditioning***

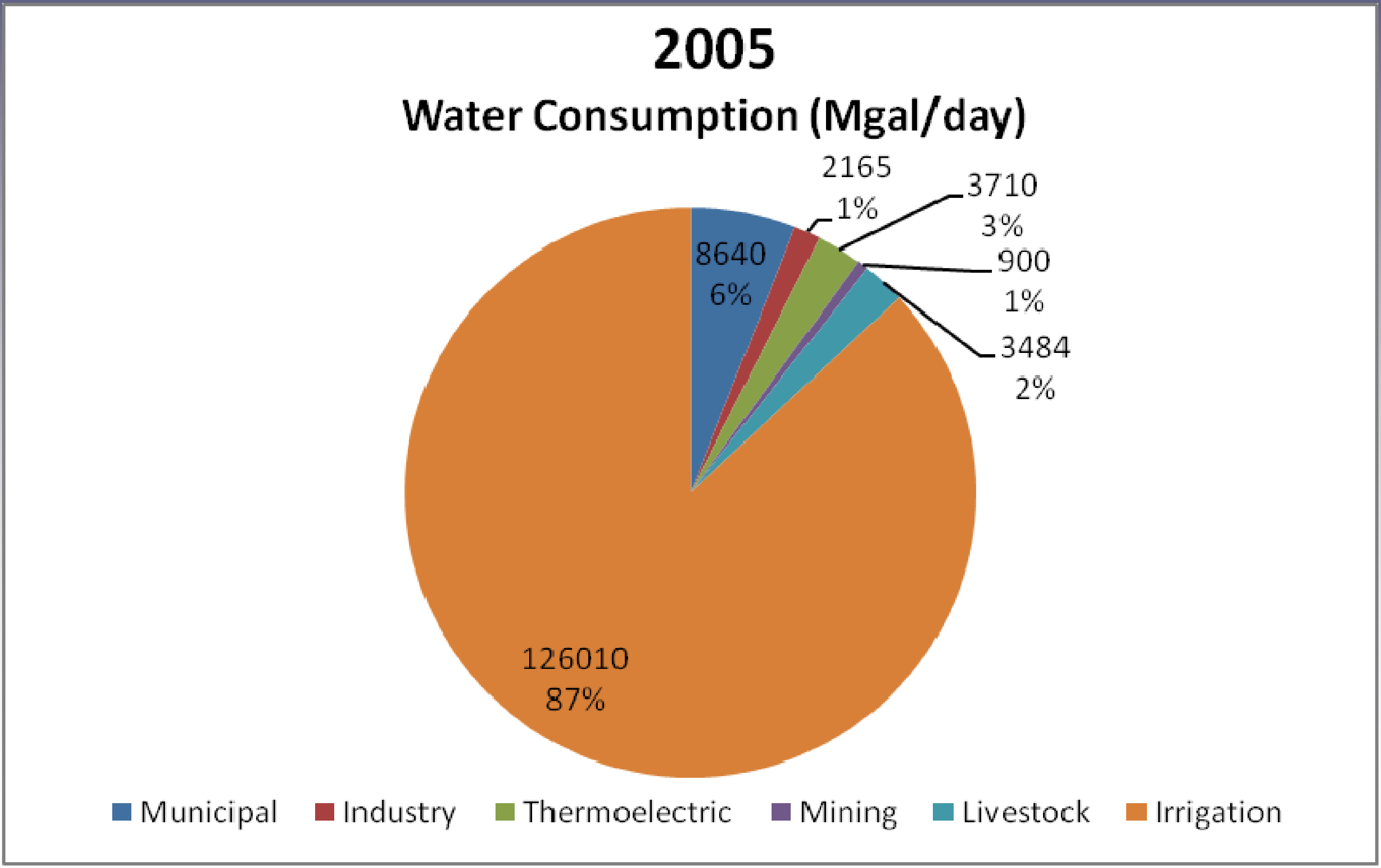
Water for Thermoelectric Power Generation



	Municipal	Industry	Thermo electric	Mining	Livestock	Irrigation
Saline	0	1710	58100	1710	0	0
Surface Water	29867	13900	142000	1300	7716	74900
Groundwater	18340	3070	510	1020	3200	53500

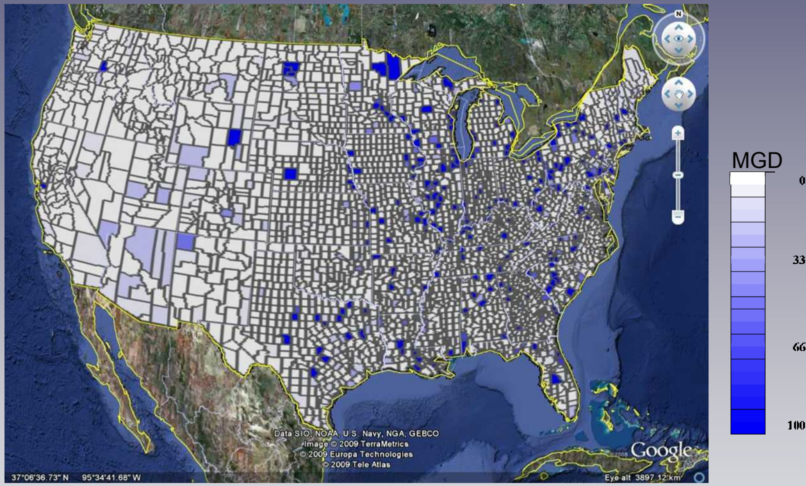
USGS 2005

Water for Thermoelectric Power Generation

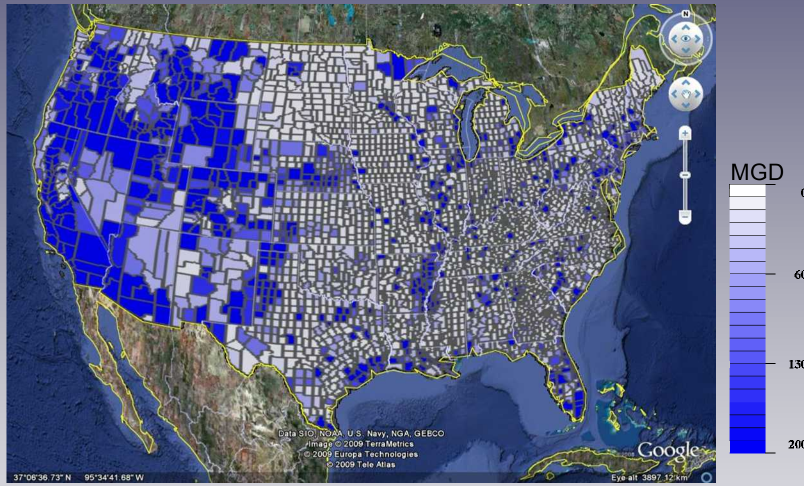


Location Maters

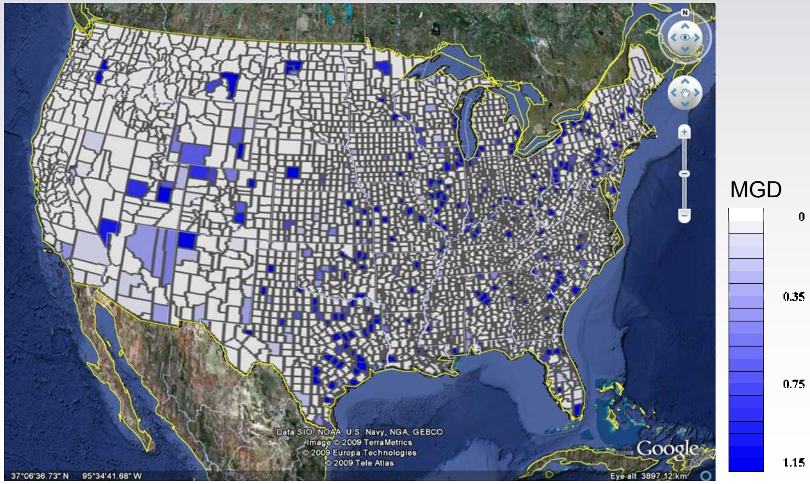
Thermoelectric Withdrawal 2005



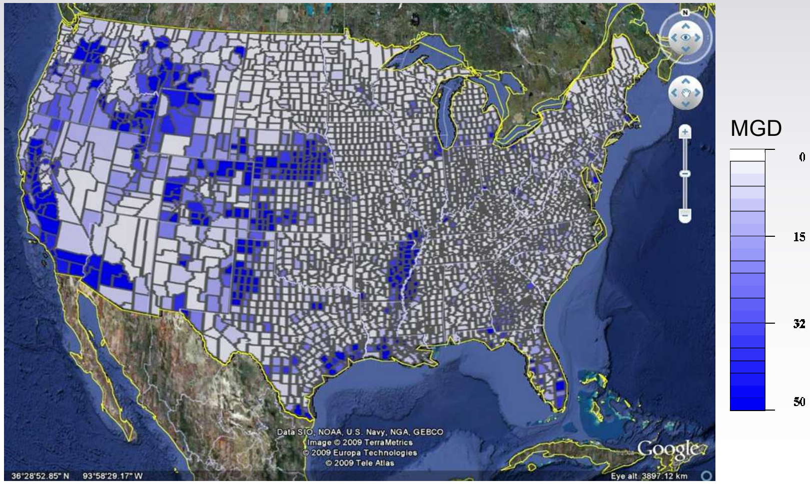
Non-Thermoelectric Withdrawal 2005



Thermoelectric Consumption 2005

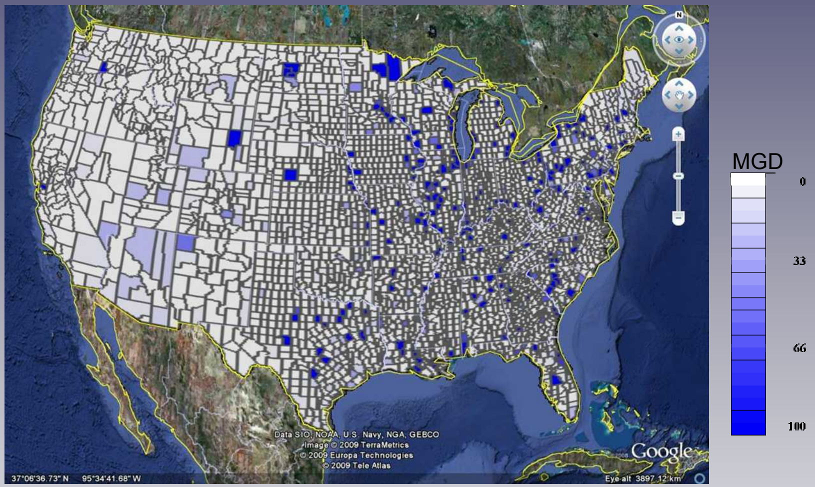


Non-Thermoelectric Consumption 2005

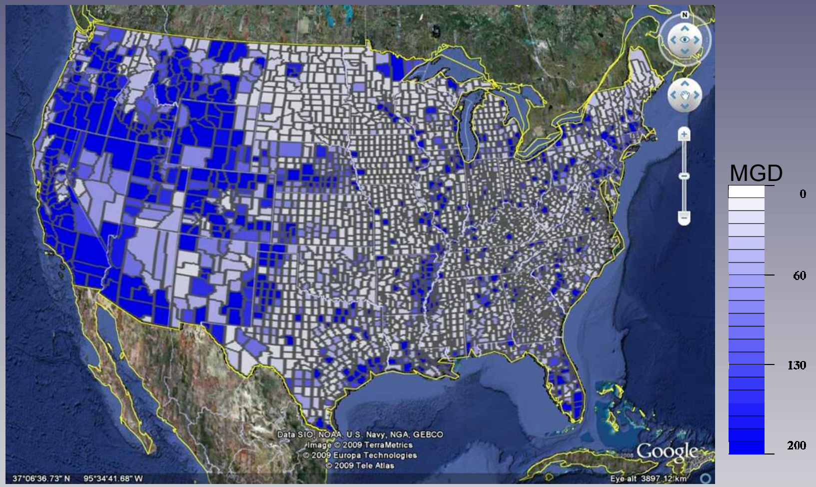


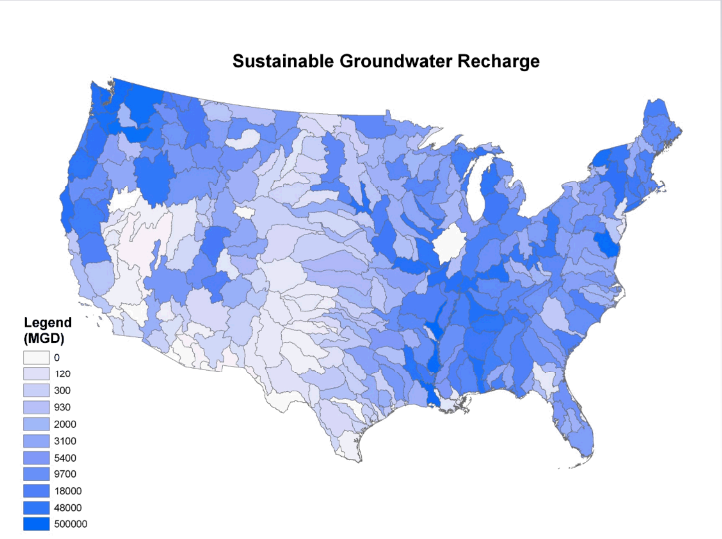
Location Maters

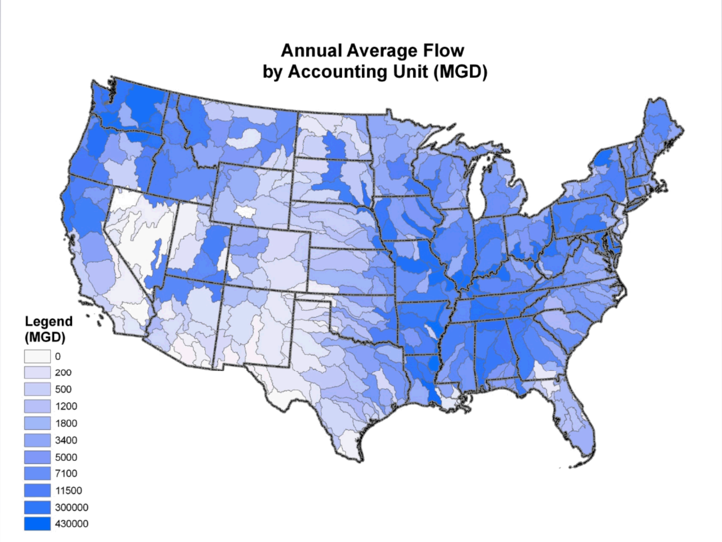
Thermoelectric Withdrawal 2005



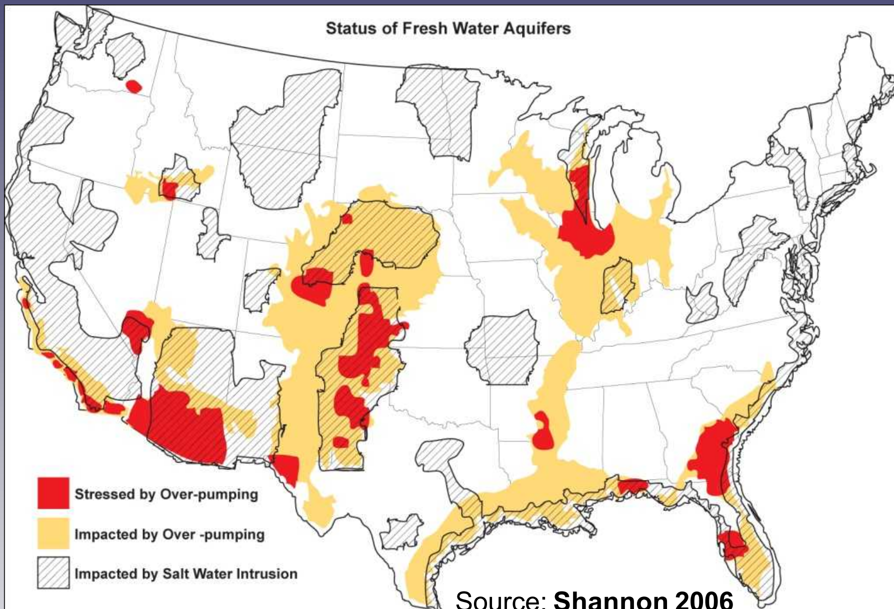
Non-Thermoelectric Withdrawal 2005



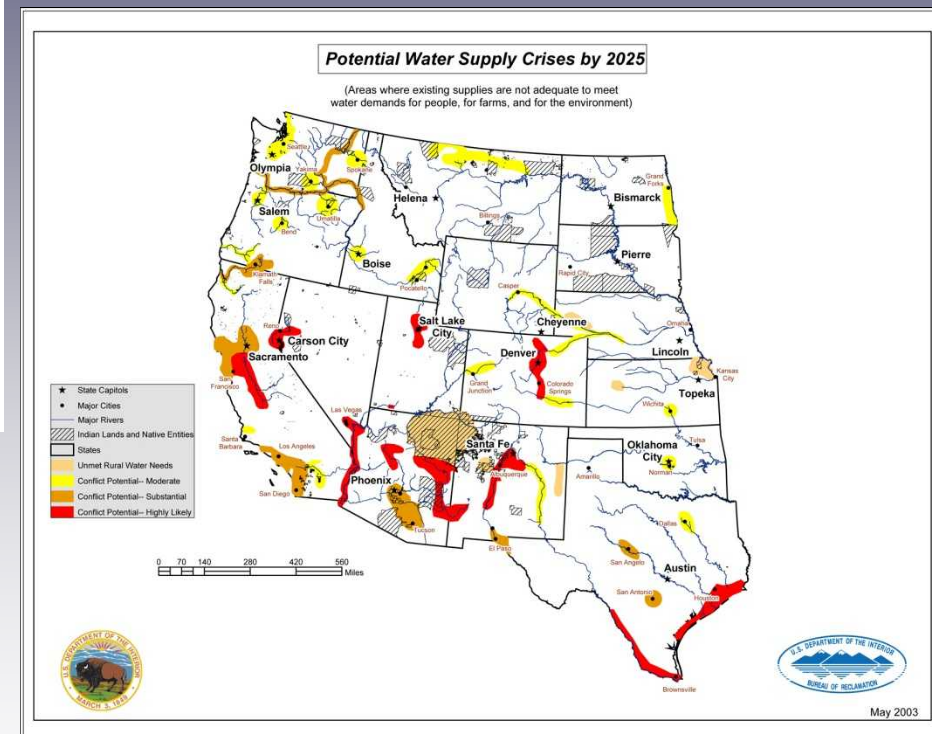


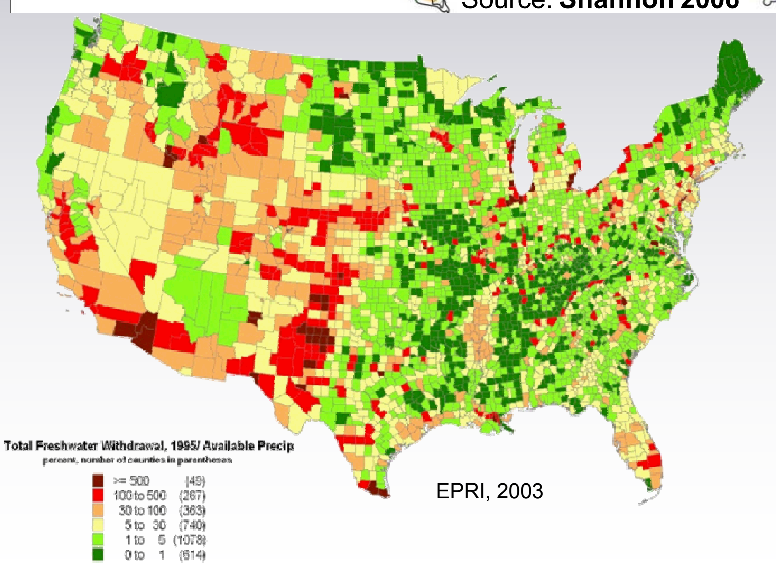


Indications of Water Stress



Source: **Shannon 2006**

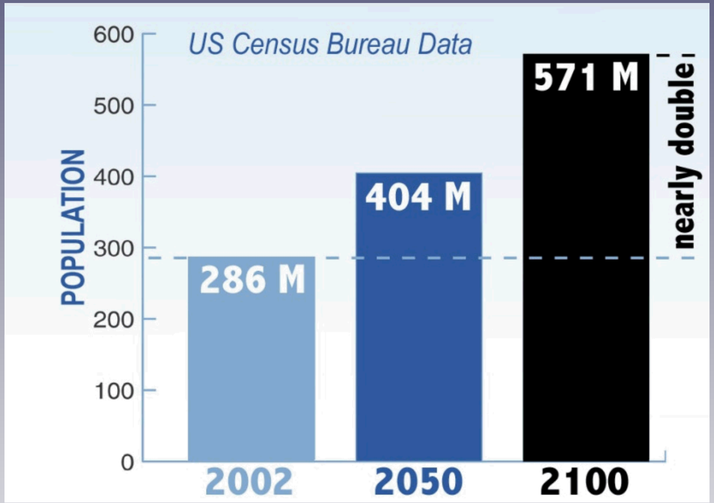




EPRI, 2003

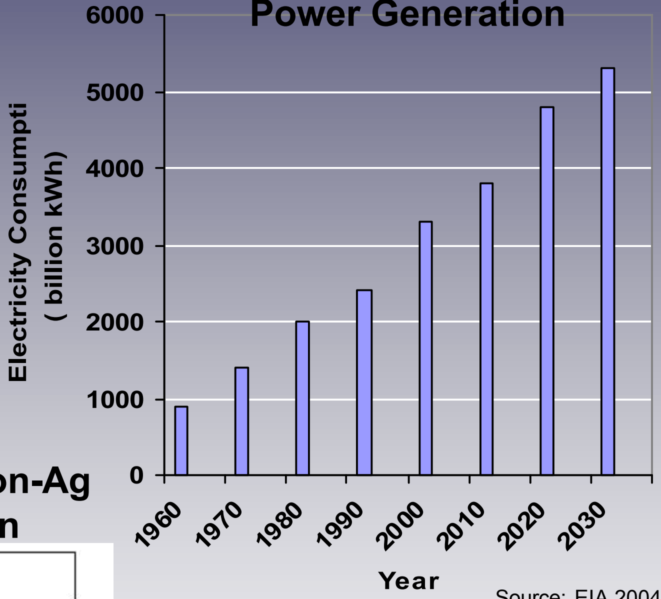
Energy and Water Tomorrow

Projected Population Growth



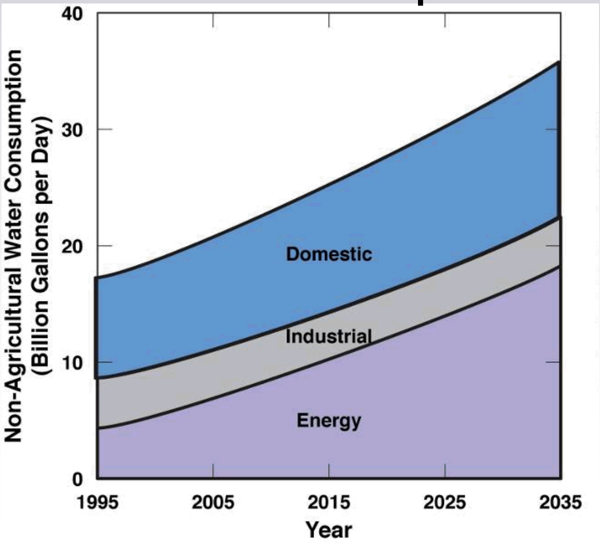
70 million more people by 2030

Projected Growth in Electric Power Generation

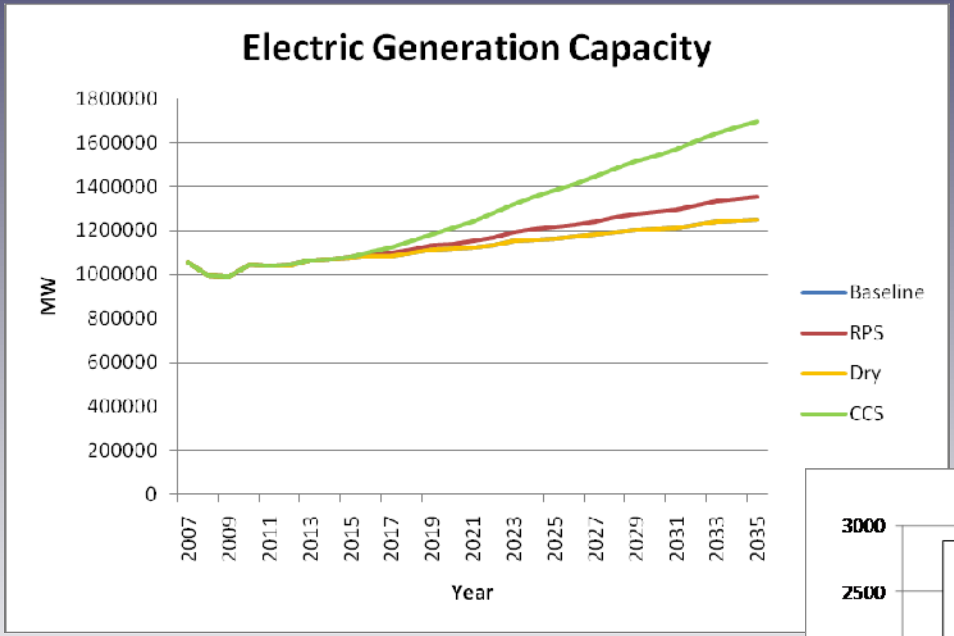


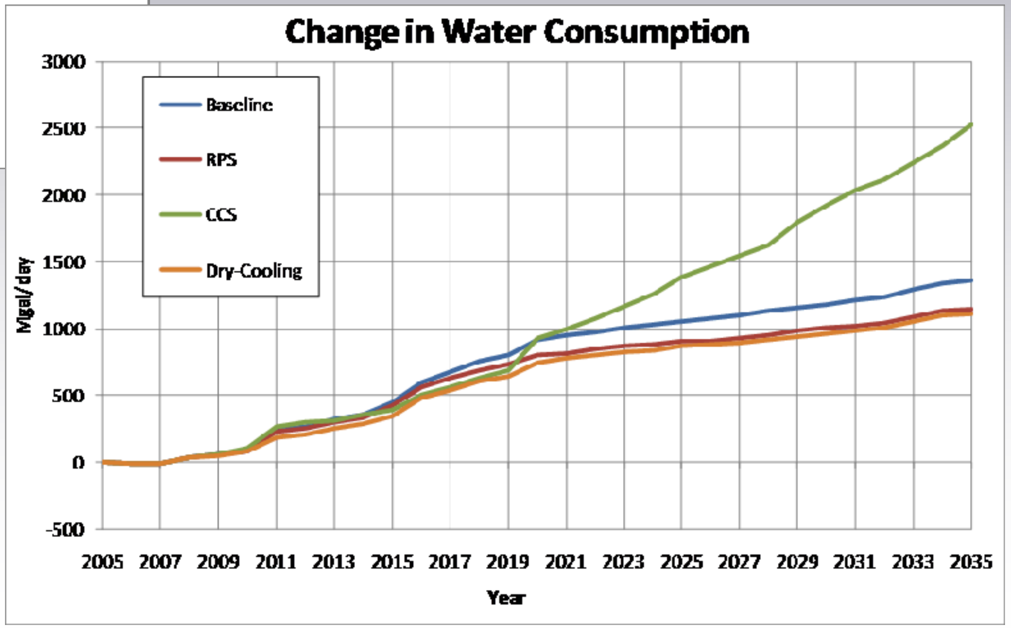
Source: EIA 2004

Projected Growth in non-Ag Water Consumption



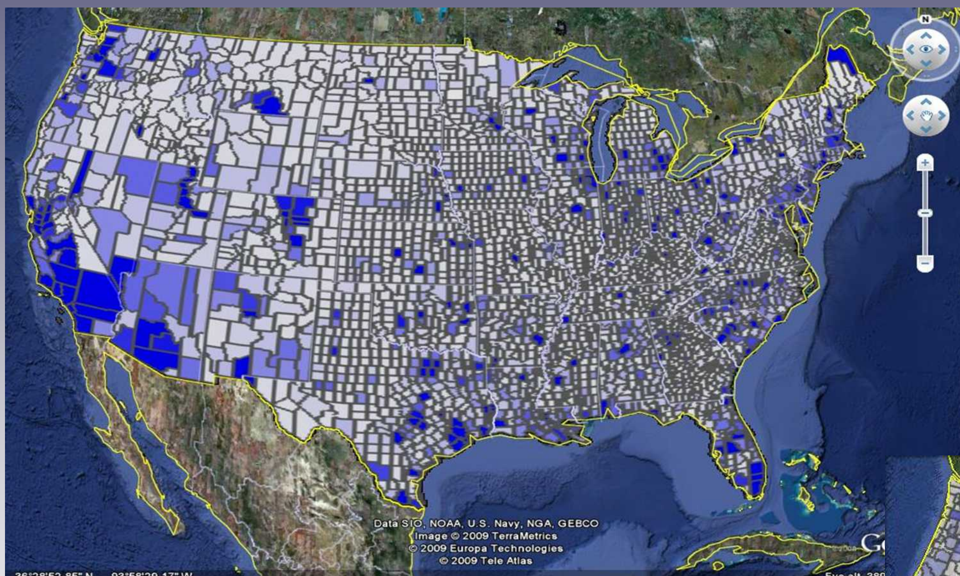
Growth in Electric Generation Capacity and Thermoelectric Consumption

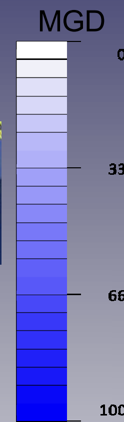




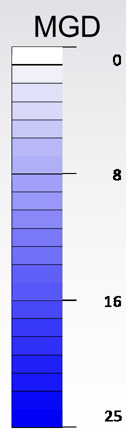
Competition Over Water

New Non-Thermoelectric Consumption:
2005-2035





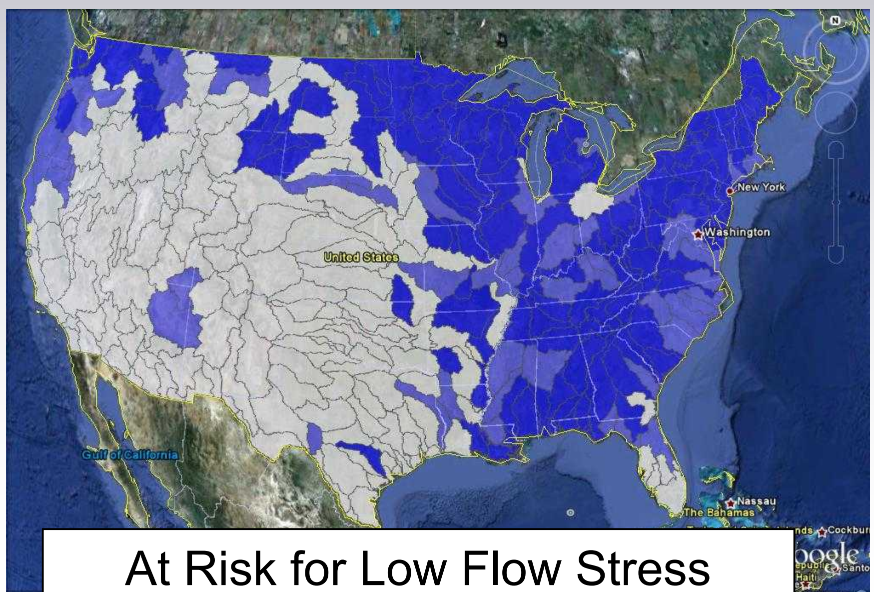
New Thermoelectric Consumption:
2005-2035



Water Stress Indicators

At Risk for Surface Water Stress

At Risk for Groundwater Stress



At Risk for Low Flow Stress

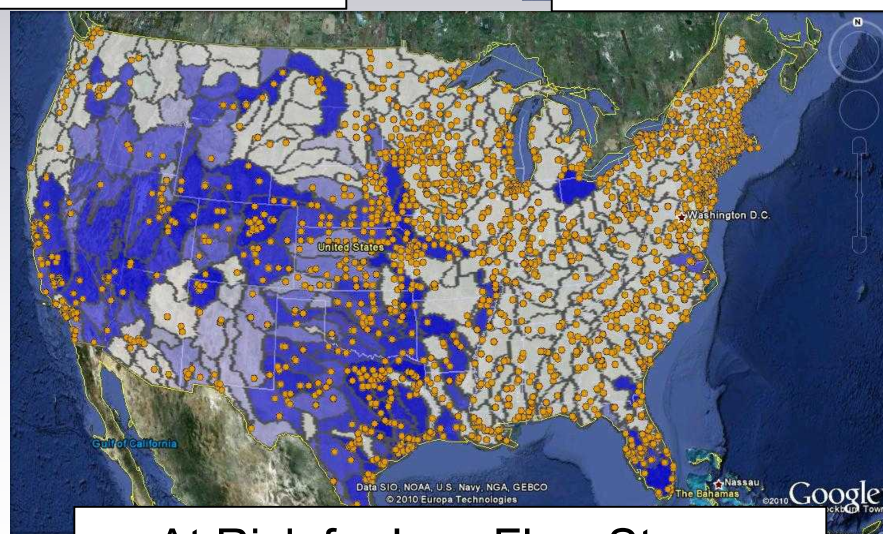
Supply / Consumption

- 1-2
- 2-10
- >10

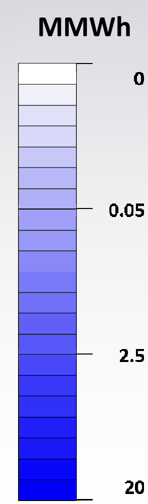
New Production in At Risk Basins

At Risk for Surface Water Stress

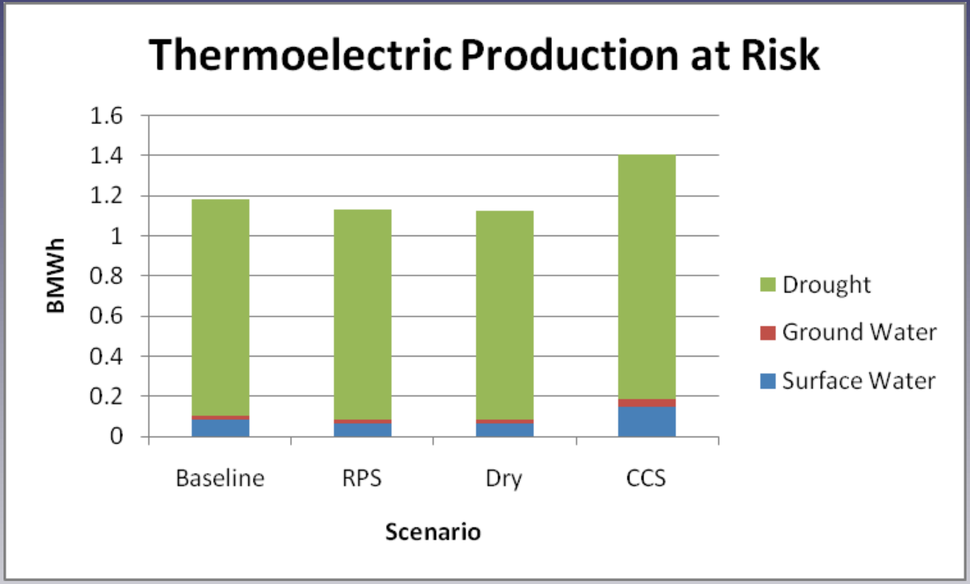
At Risk for Groundwater Stress

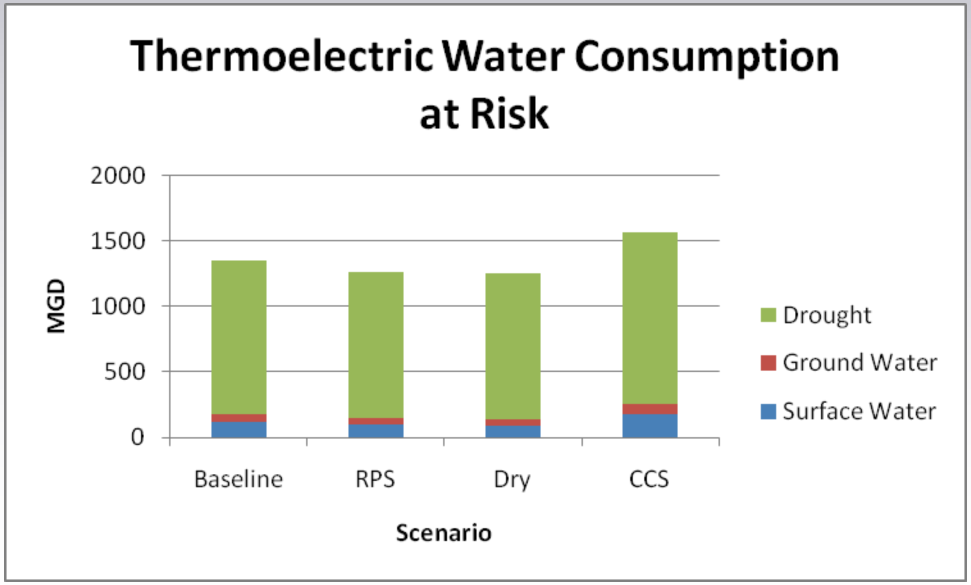


At Risk for Low Flow Stress

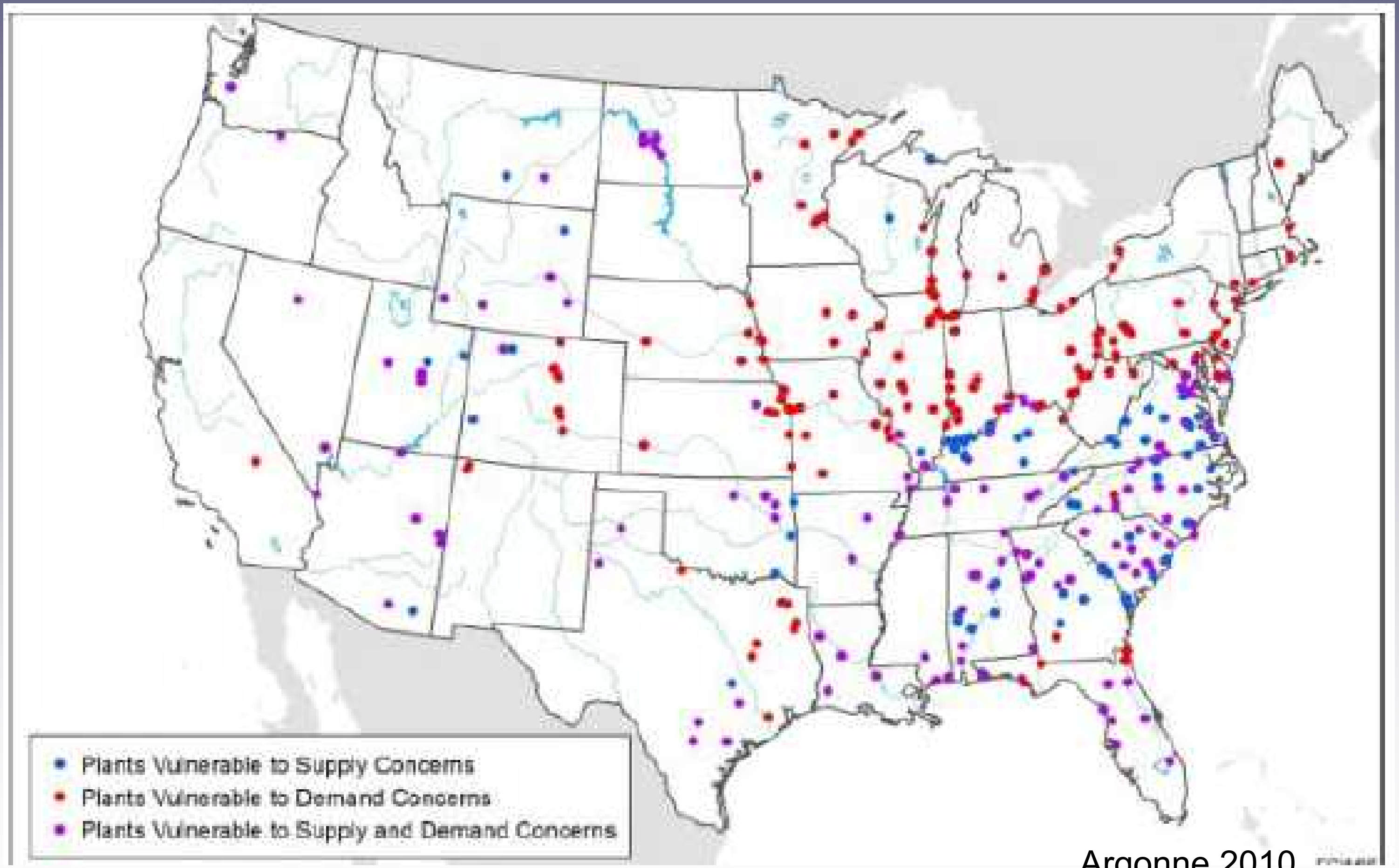


At Risk Production





Thermoelectric Power at Risk of Drought



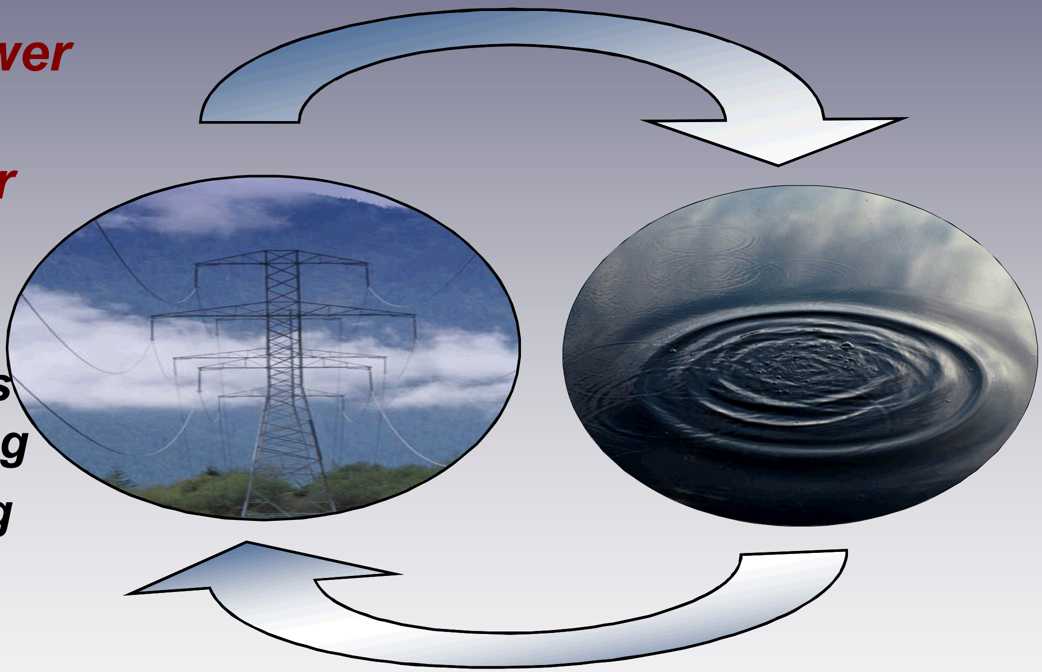
Argonne 2010

Water for Energy

Energy for Water

Energy and power production requires water

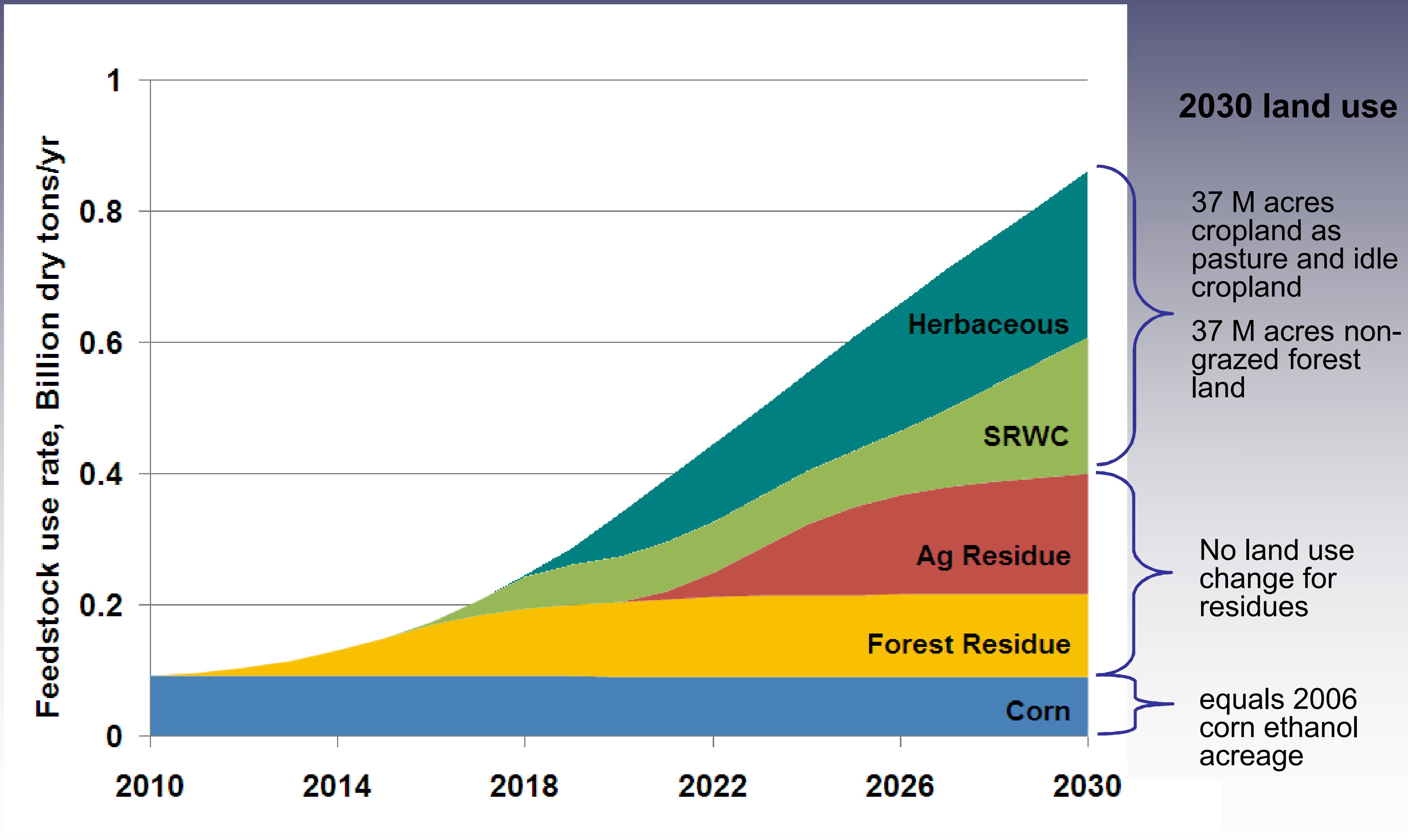
- Thermoelectric Cooling
- Energy Minerals Extraction/Mining
- Fuel Processing (fossil fuels, H_2,biofuels)
- Emission Control



Water production, processing, distribution, and end-use requires energy

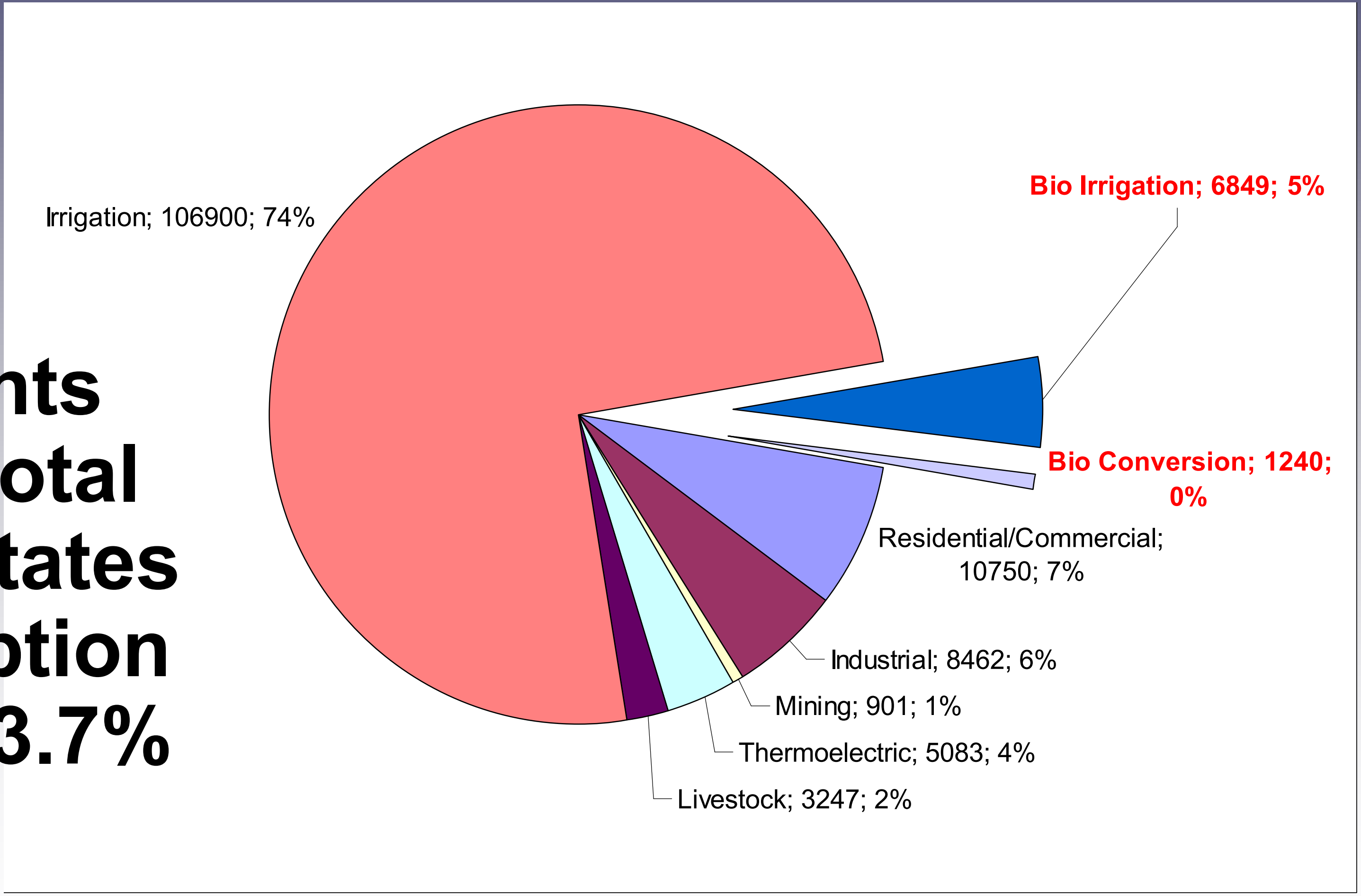
- Pumping
- Conveyance
- Treatment
- Distribution
- Use Conditioning

Biofuel Water Use



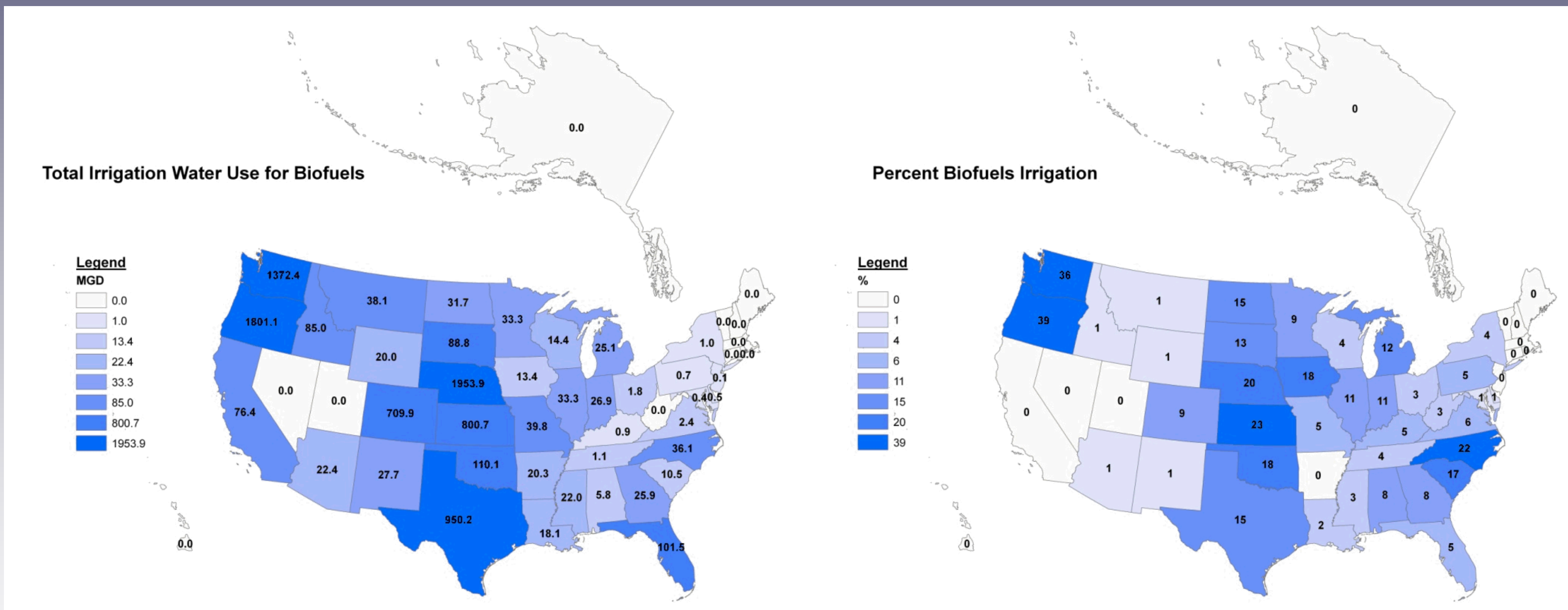
Water Demand Projection Model

Biofuel Water Consumption: 2030

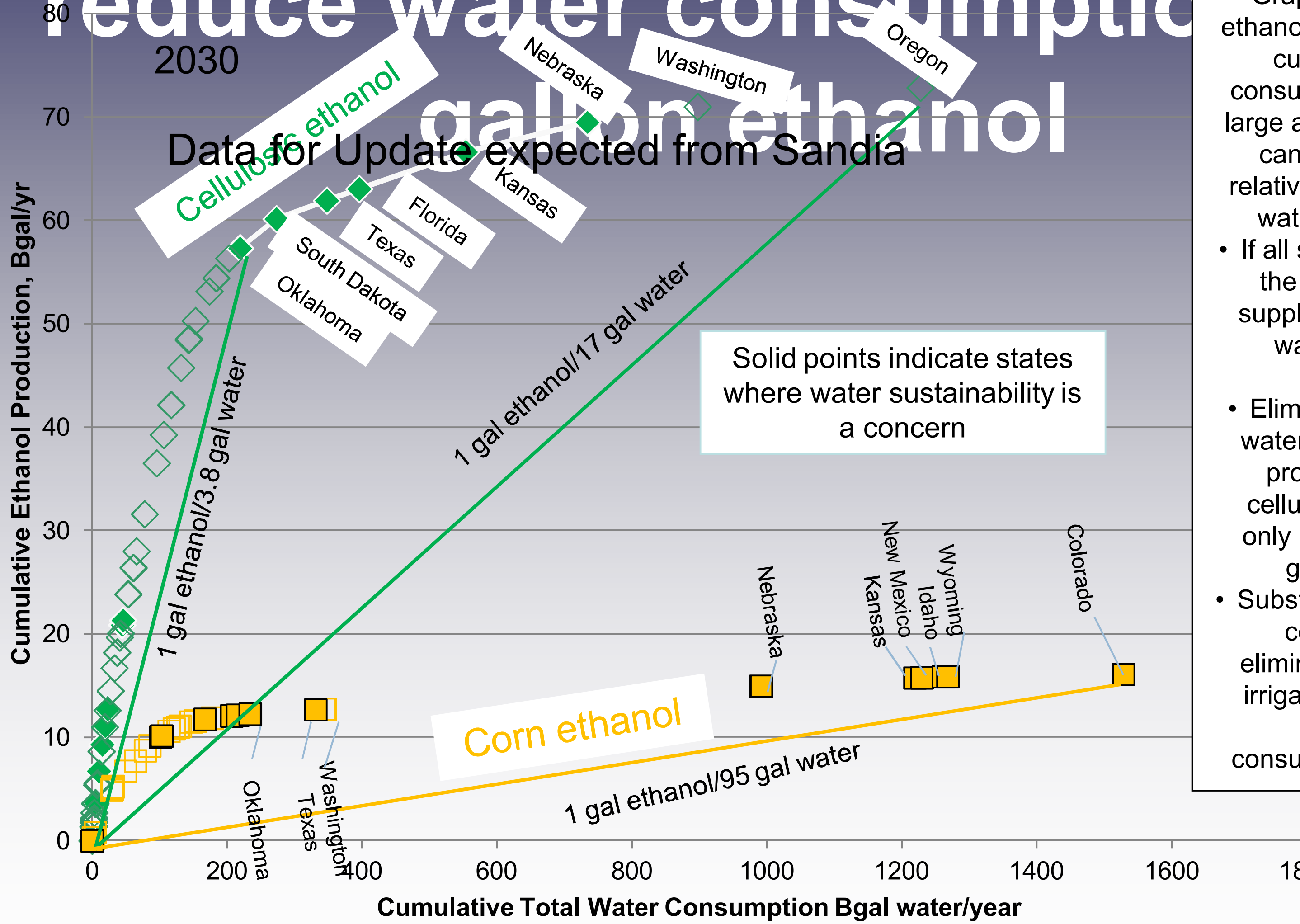


Represents 5.6% of total United States consumption up from 3.7% in 2007

Water Use for Irrigation



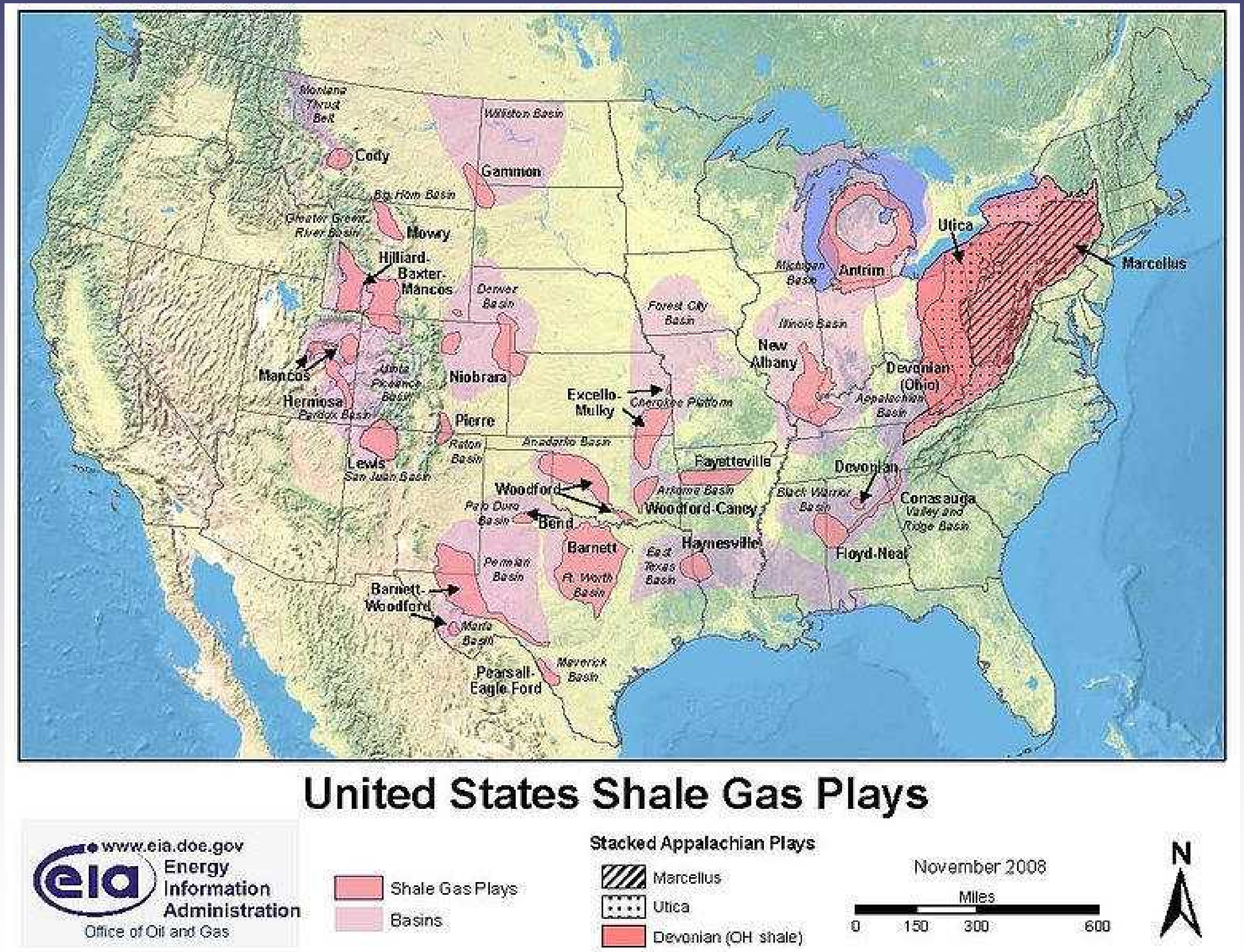
corn ethanol and eliminating high use water states can greatly reduce water consumptio gallon ethanol



Graphing cumulative ethanol production versus cumulative water consumption shows that large amounts of biofuels can be produced at relatively low impacts on water consumption.

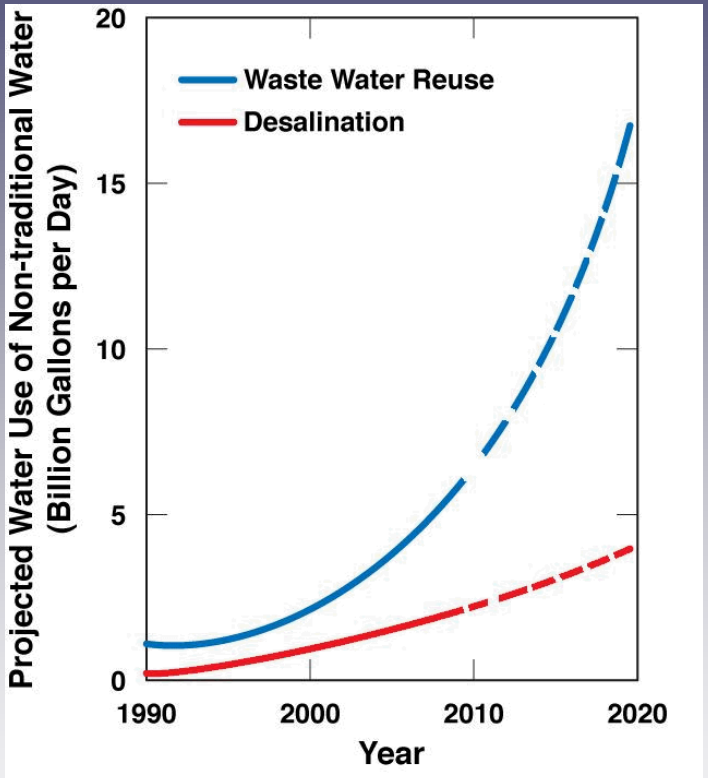
- If all states are included, the cellulosic ethanol supply chain uses 17 gal water per gallon of ethanol
- Eliminating the highest water consuming states, provides 58 B gal of cellulosic ethanol using only 3.8 gal of water per gallon of ethanol
- Substituting cellulosic for corn ethanol and eliminating the high corn irrigation states will also reduce water consumption substantially

Water Use for Energy Extraction

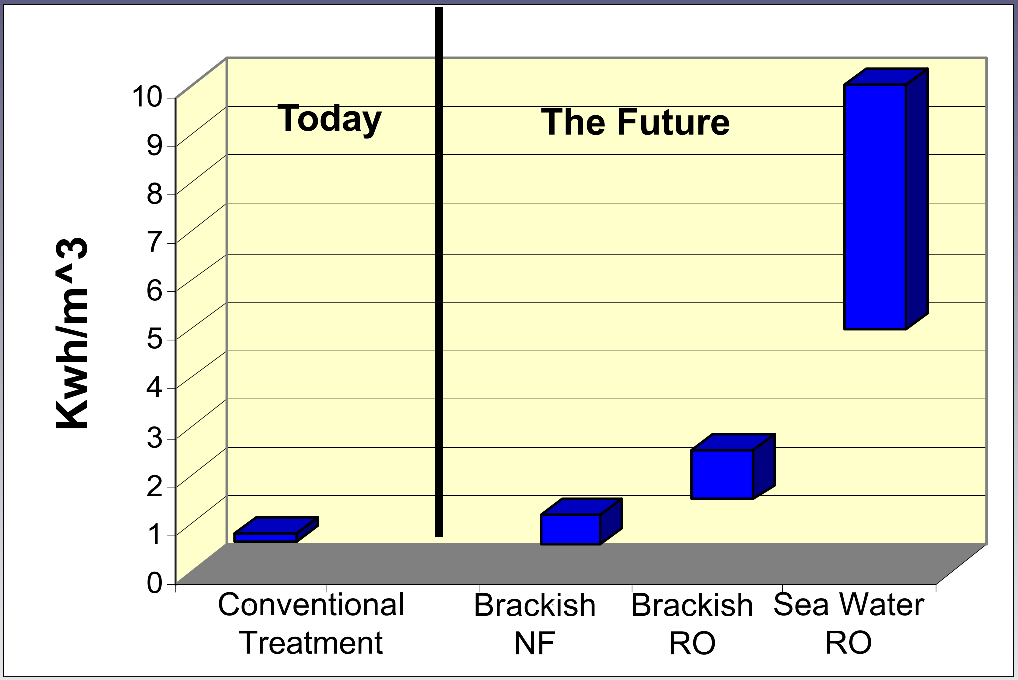


Water Demand Projection Model

Power Requirements For Treatment



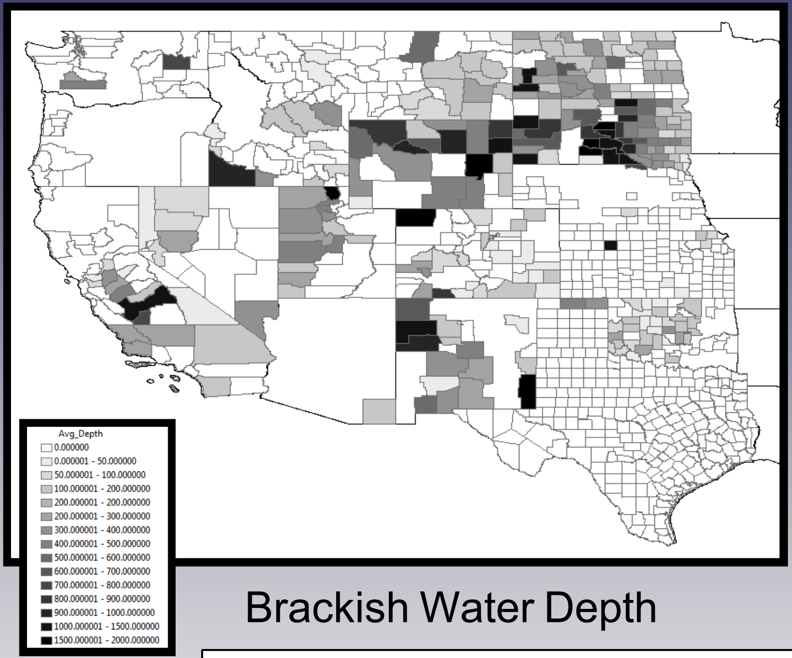
(Modified from Water Reuse 2007, EPA 2004, Mickley 2003)



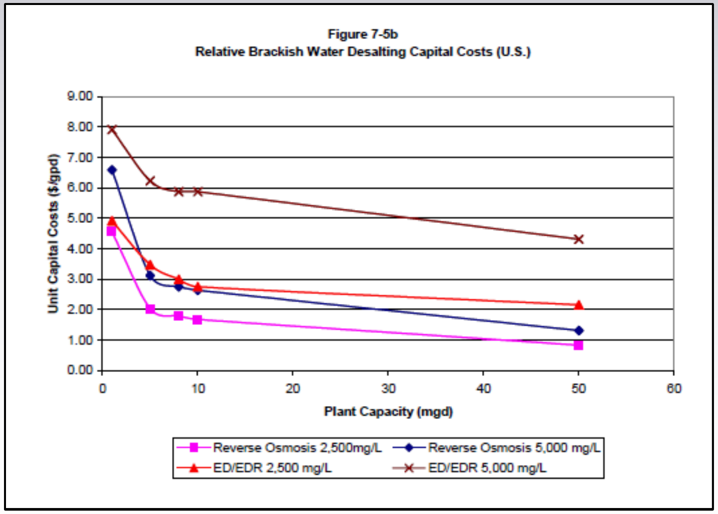
(Einfeld 2007)

- Desal growing at 10% per year, waste water reuse at 15% per year
- Non-traditional water use is energy intensive

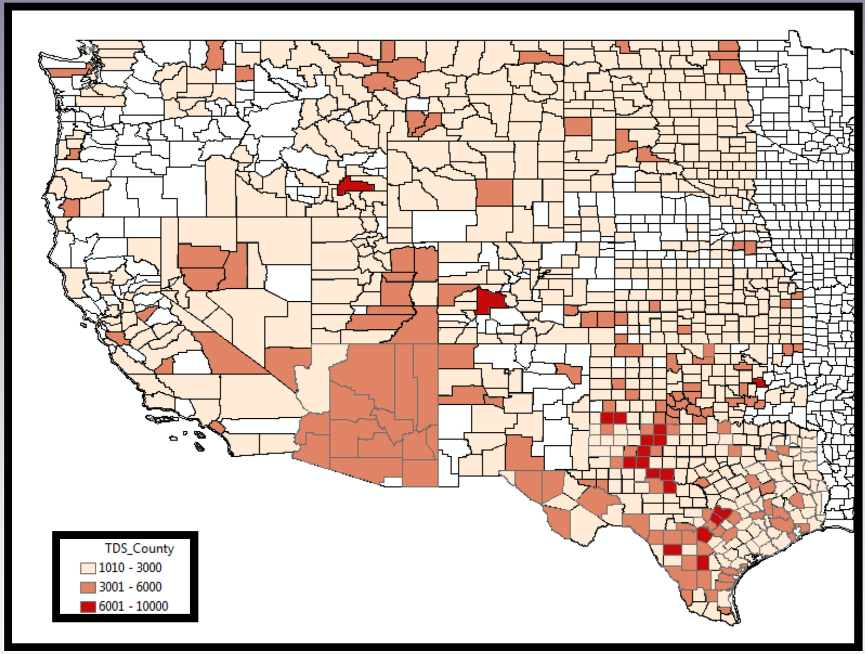
Water Availability Indicators: Supply



Brackish Water Depth



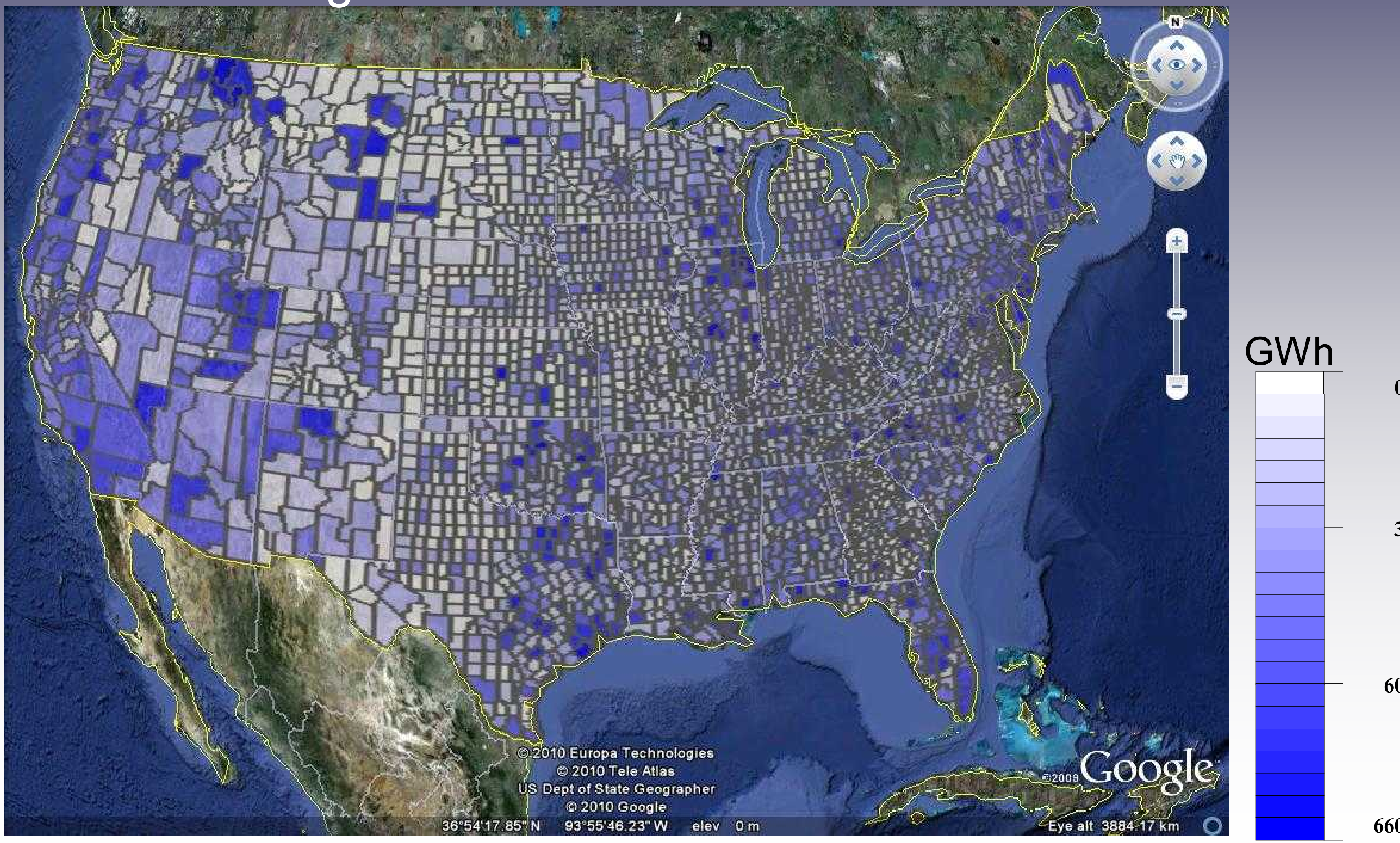
Brackish Water Treatment



Brackish TDS Levels

Energy for Water

Projected Increase in Demand for Electricity due to Growing Demand for Water: 2004-2030



Project Objectives

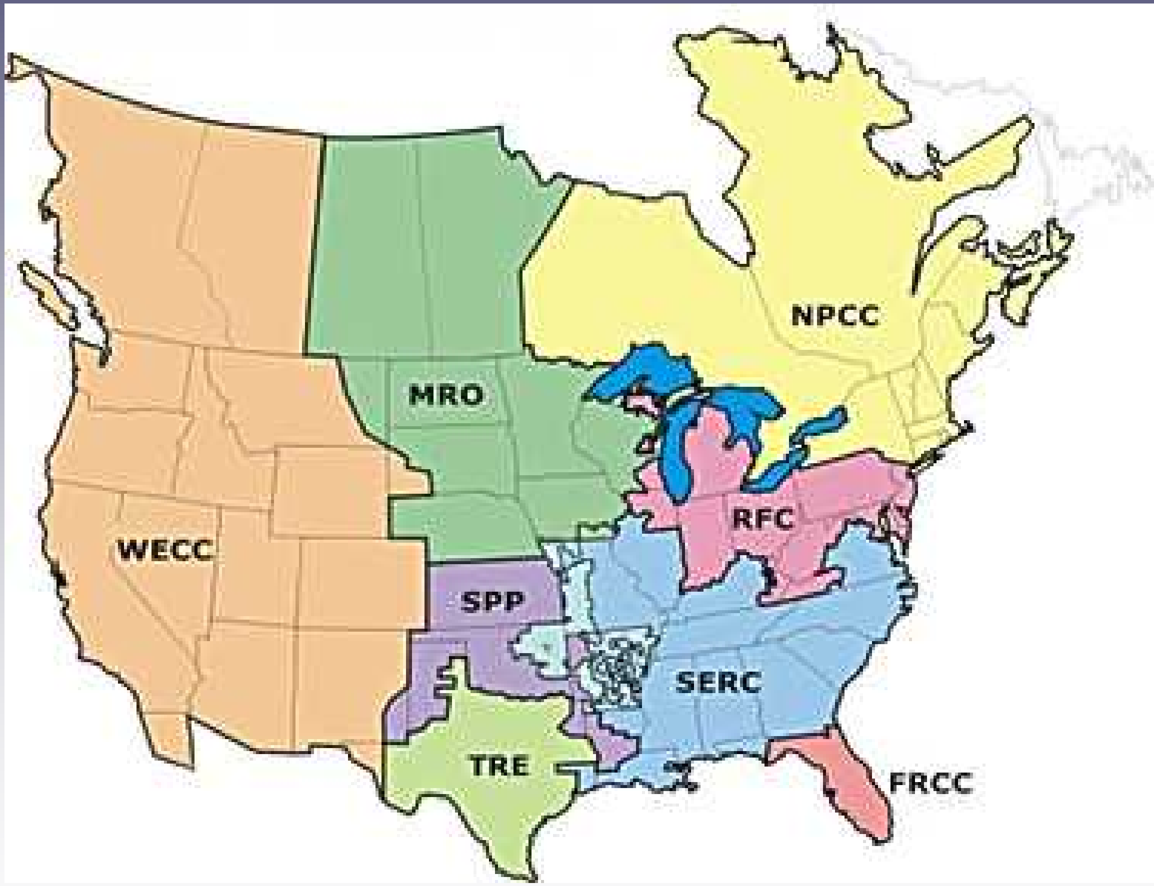
- Develop an integrated Energy-Water Decision Support System (DSS) that will enable planners to analyze the potential implications of water stress for transmission and resource planning.
- Pursue the formulation and development of the Energy-Water DSS through a strongly collaborative process between Western Electricity Coordinating Council, Electric Reliability Council of Texas, Western Governors' Association, and Western States Water Council.
- Exercise the Energy-Water DSS to investigate water transmission planning scenarios.

Project Partners

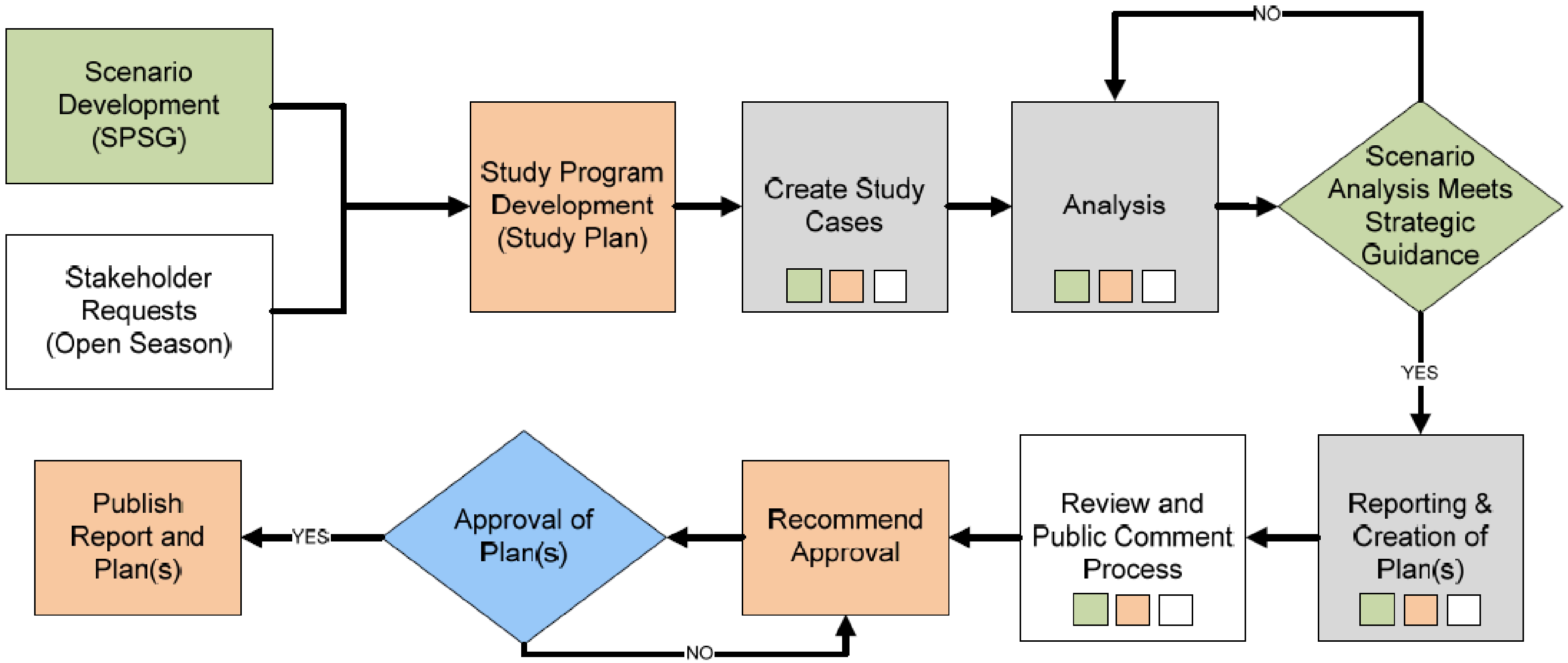
- Sandia National Laboratories
  - Vincent Tidwell
  - Barbie Moreland
  - Howard Passell
- Argonne National Laboratory
  - John Gasper
  - John Veil
  - Chris Harto
- Electric Power Research Institute
  - Robert Goldstein
- National Renewable Energy Laboratory
  - Jordan Macknick
  - Robin Newmark
  - Daniel Inman
  - Kathleen Hallett
- Idaho National Laboratory
  - Gerald Sehlke
  - Randy Lee
- Pacific Northwest National Laboratory
  - Mark Wigmosta
  - Richard Skaggs
  - Ruby Leung
- University of Texas
  - Michael Webber
  - Carey King

Project Domain

- Project duration:
  - 24 months for WECC
  - 18 months for ERCOT
- Planning horizon is to 2030



Transmission Planning



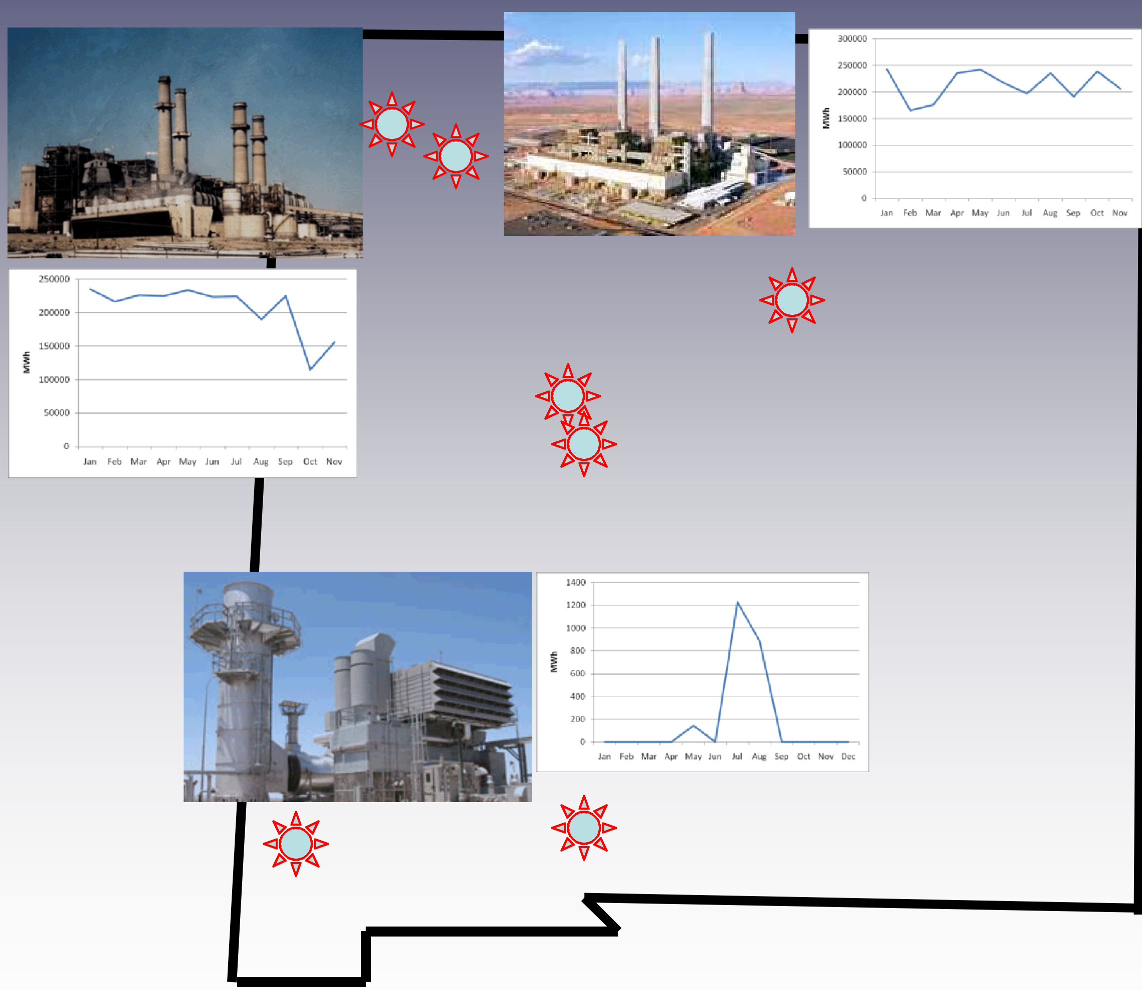
Decision Body

- Scenario Planning Steering Group
- TEPPC
- WECC Board
- TEPPC Workgroup Concensus
- Public

Note – The small boxes represent opportunities for stakeholders to be directly involved in planning processes.

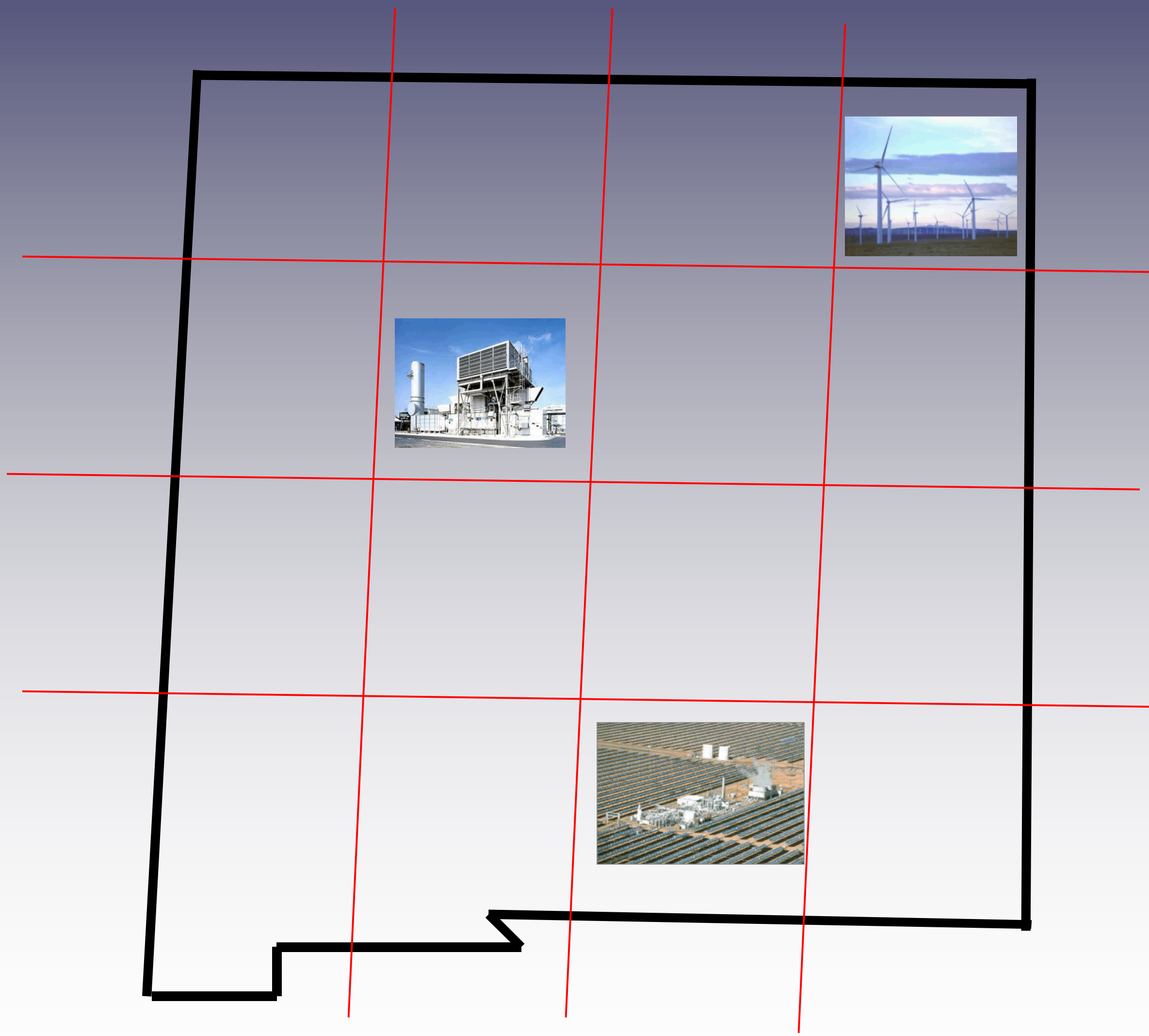
TEPPC Workgroup activities are open to all and decisions are made by consensus. It is at these meetings where many of the details of the planning process are decided.

Transmission Planning Output: Operations at Existing Plants



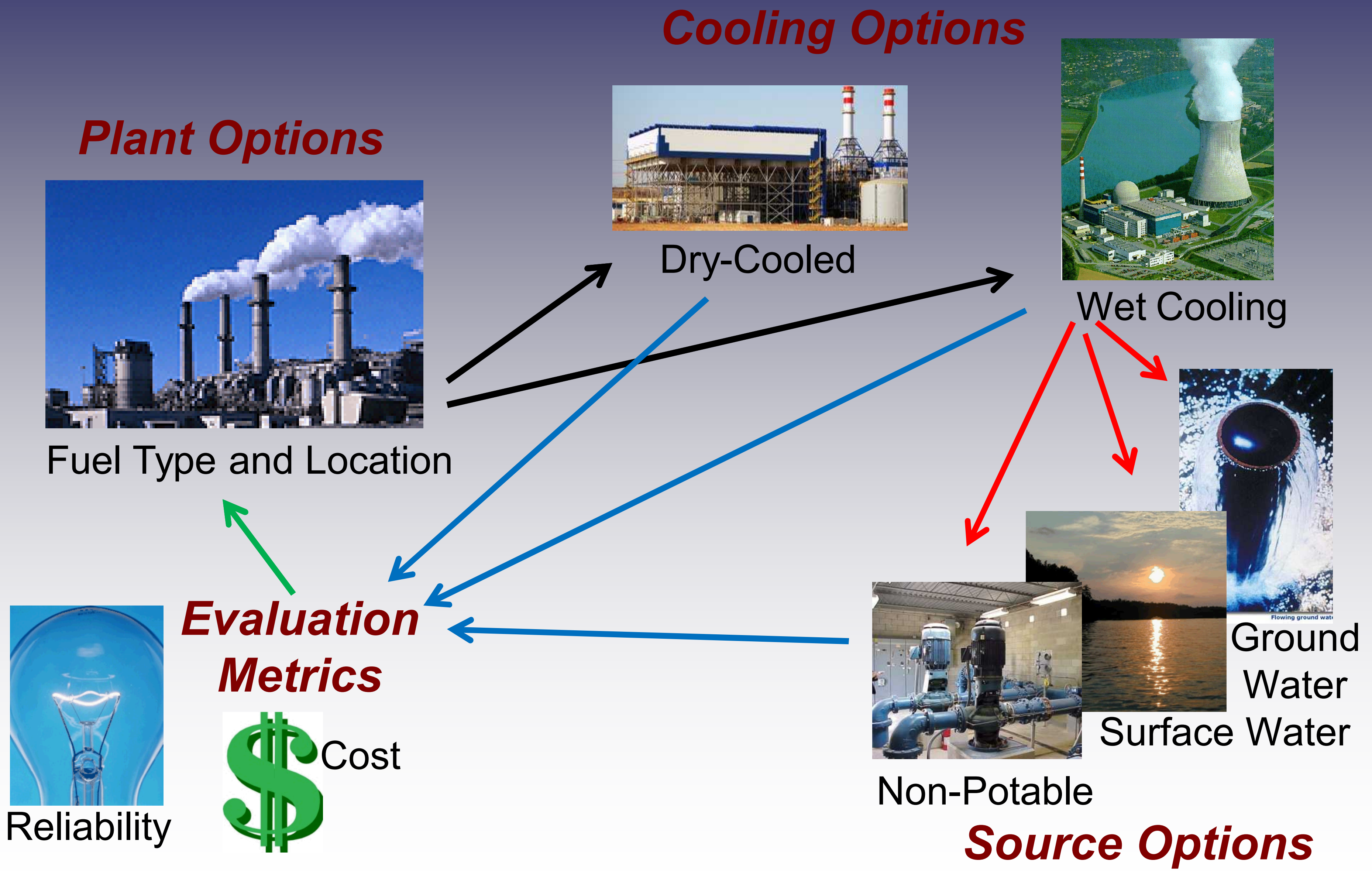
- ***Plant Characteristics***
  - ***System Upgrades, and***
  - ***Production, or***
  - ***Retirement***

Transmission Planning Output: New Power Plant Siting



- ***Plant Characteristics***
  - ***Location,***
  - ***Fuel Type,***
  - ***Size, and***
  - ***Production***

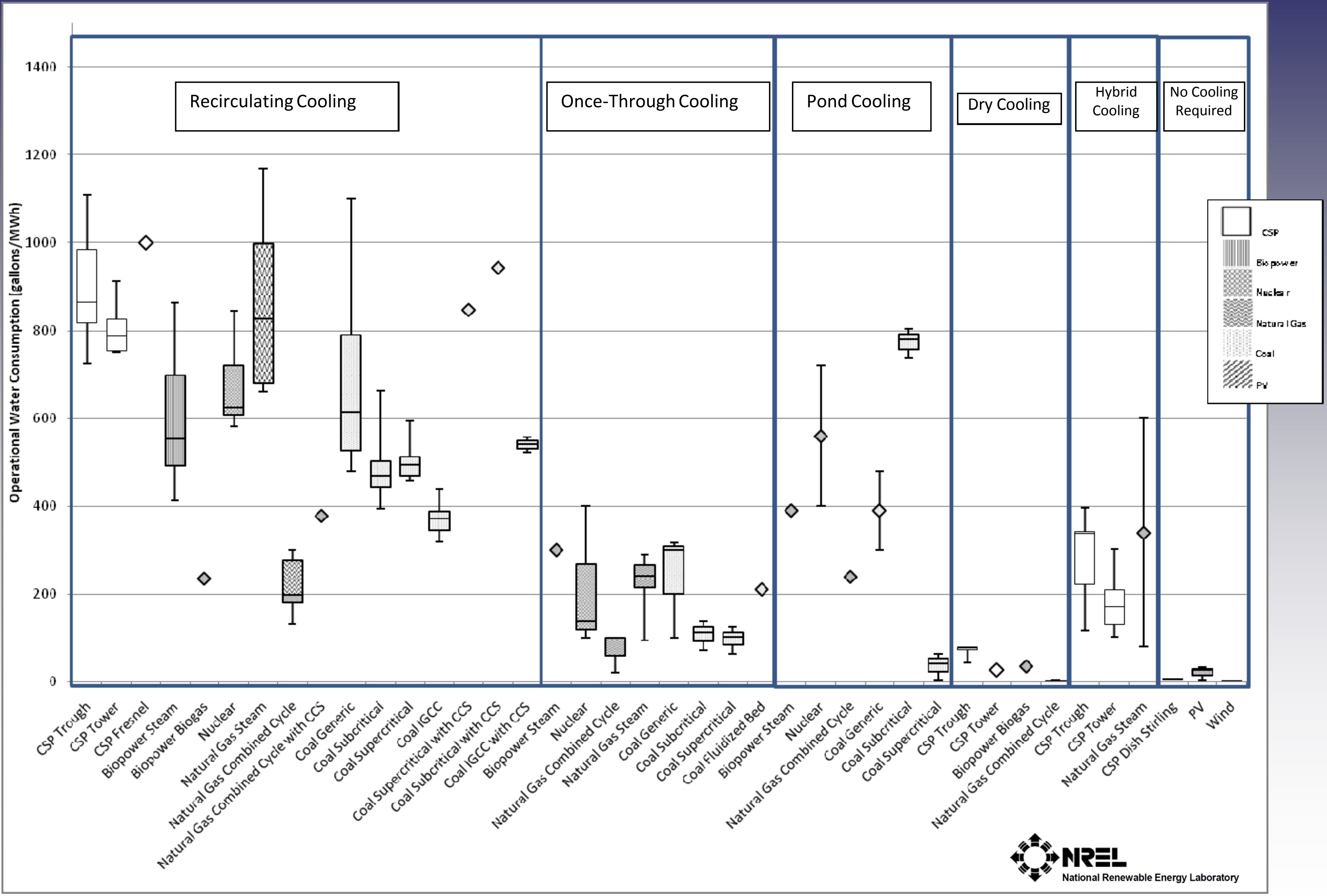
Plant Level Evaluation/Tradeoffs



Driving Questions

- ***How "difficult" would it be to acquire new water in a given basin?***
- ***How "vulnerable" are existing plants to drought related water supply disruptions?***
- ***What limited set of metrics best characterize answers to these questions?***

Thermoelectric Water Use

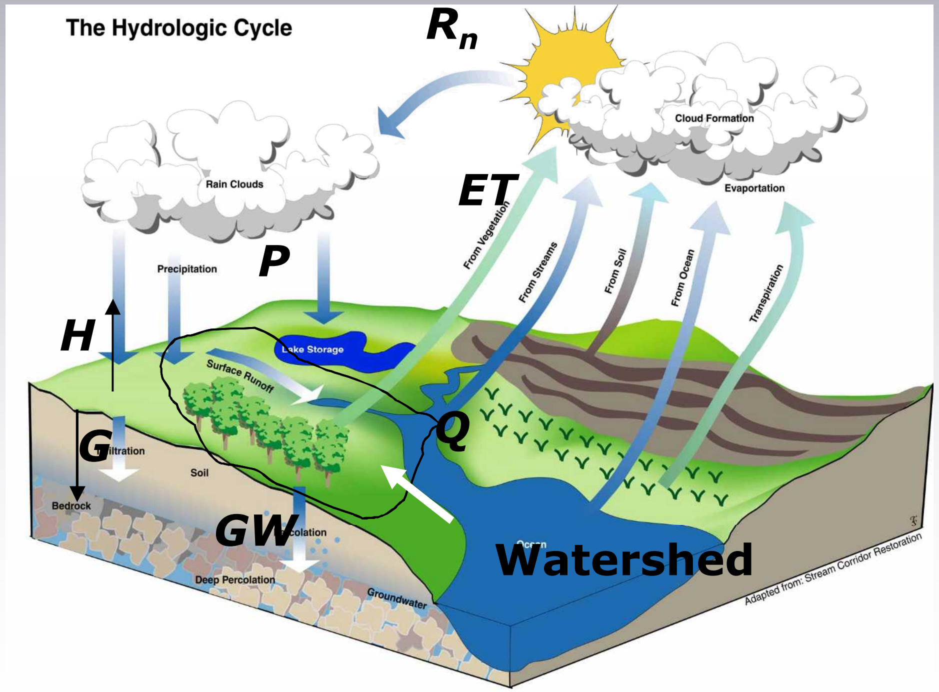


Water Availability Indicators

- ***Water Demand***
- ***Water Supply***
- ***Drought Vulnerability***
- ***Institutional Factors***
- ***Value of Water***

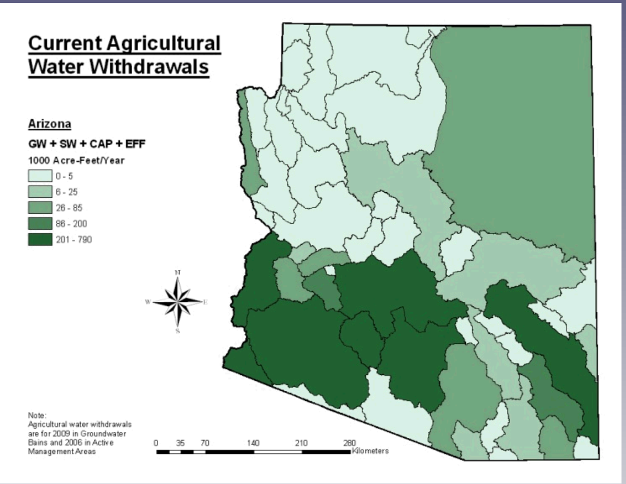
Physical Water

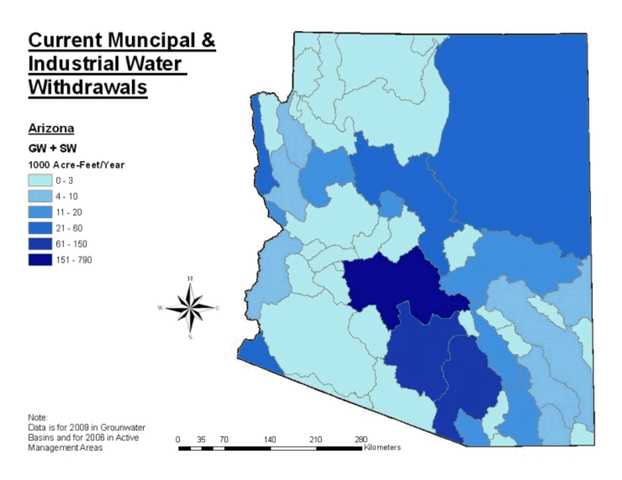
Physical Water Budget

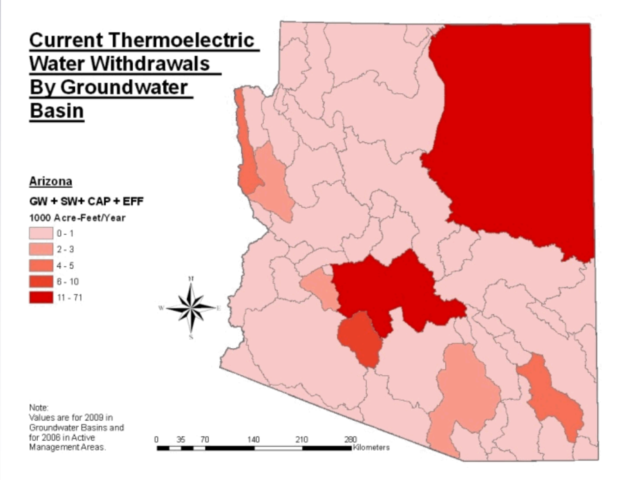


Water Availability Indicators: Demand

- ***Focus on withdrawals***
- ***Estimate consumption from withdrawals***
- ***Disaggregate by:***
  - ***8-digit watershed***
  - ***Sector***
    - ***M&I***
    - ***Agriculture***
    - ***Evaporative***
    - ***Instream***
  - ***Water source***

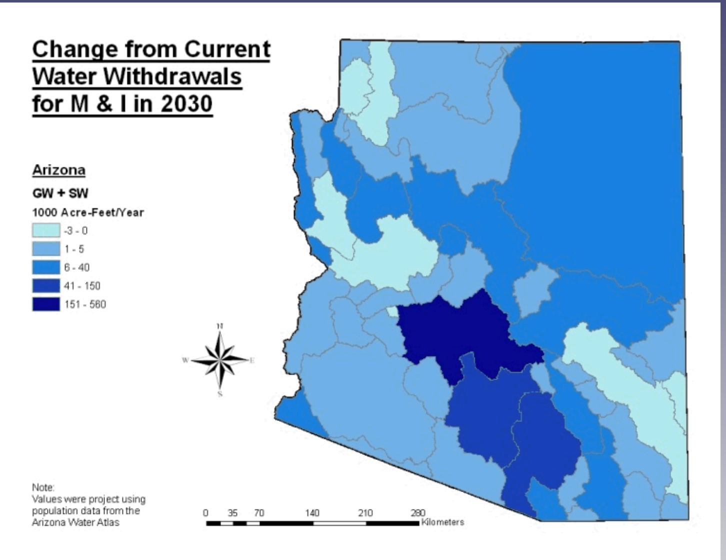


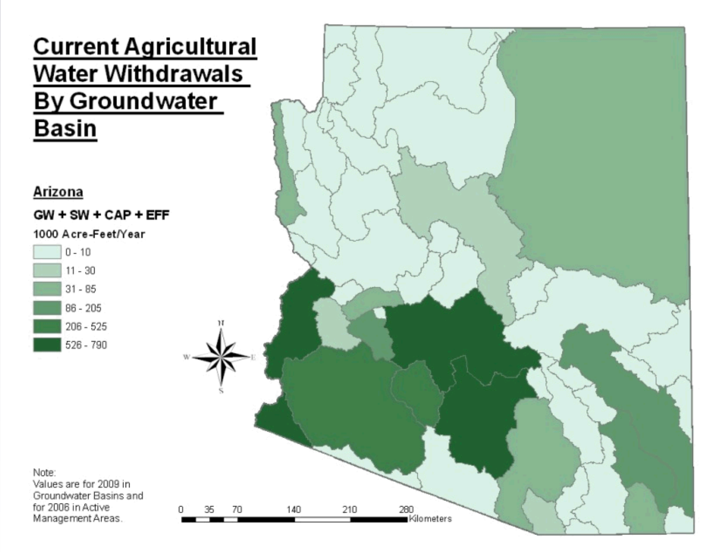




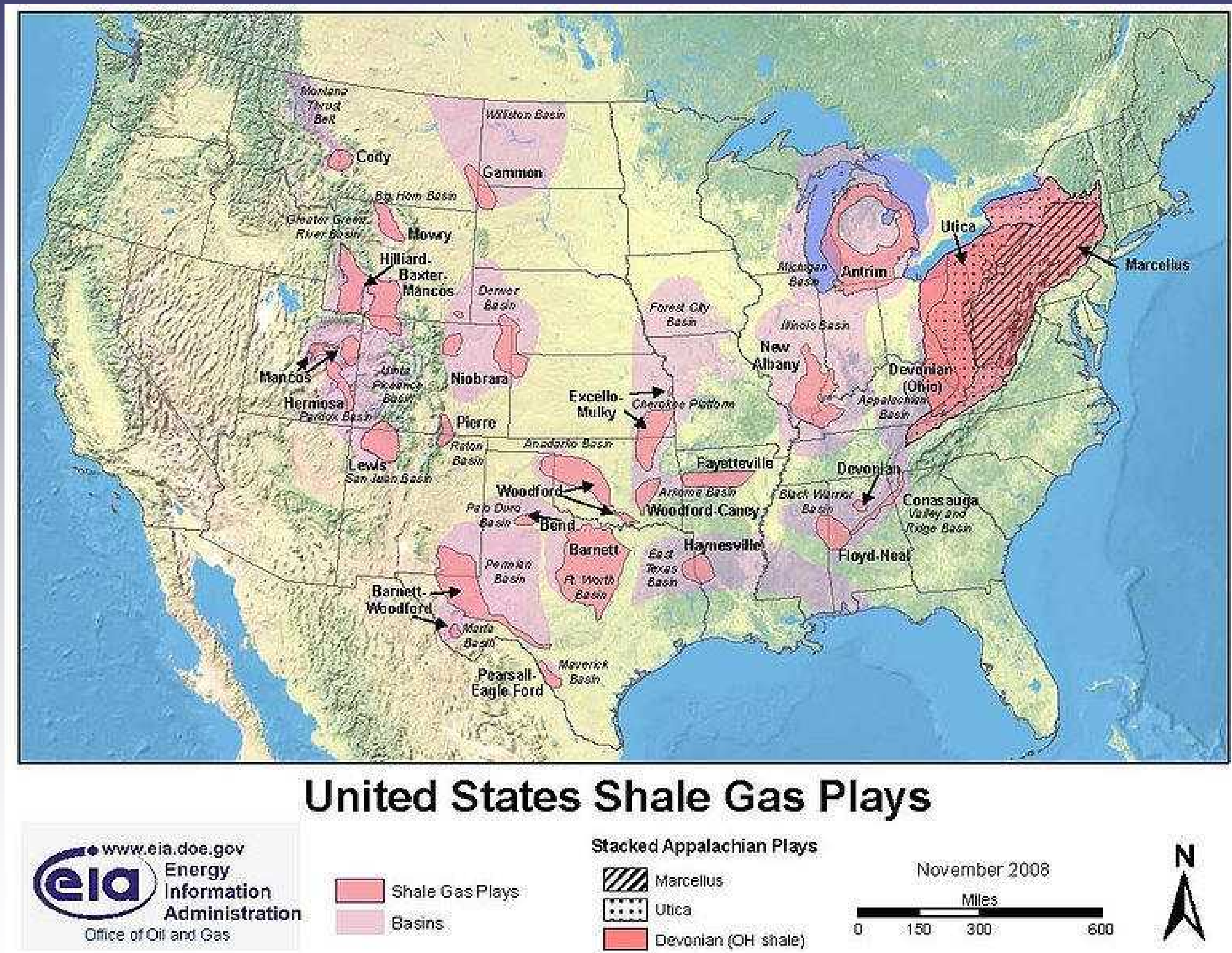
Water Availability Indicators: Demand

- ***Projected growth***
  - ***High and***
  - ***Low cases***
- ***Identify state projected growth areas for power production***

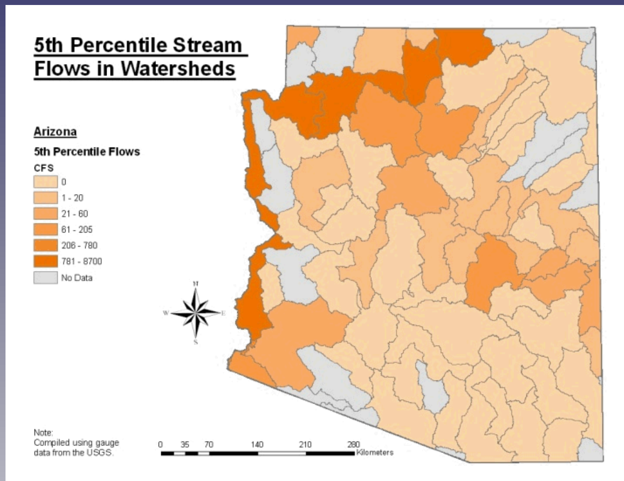




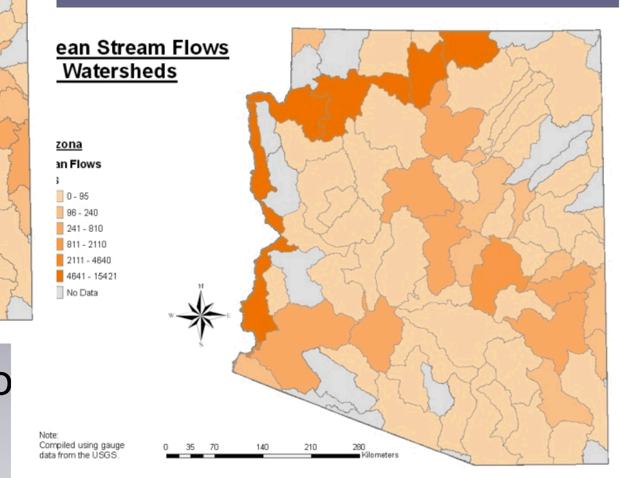
Water Availability Indicators: Demand



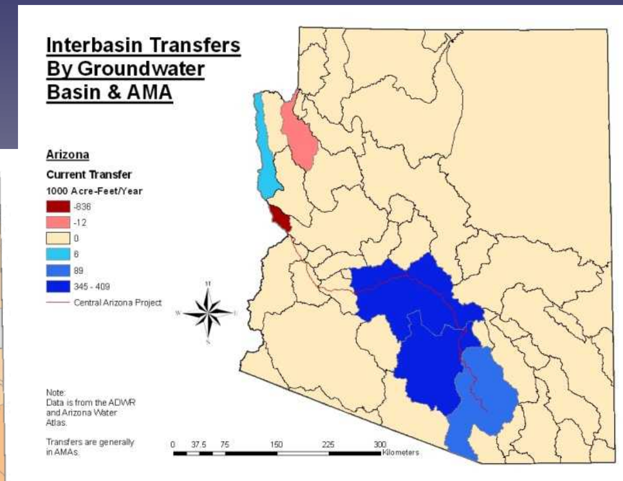
Water Availability Indicators: Supply



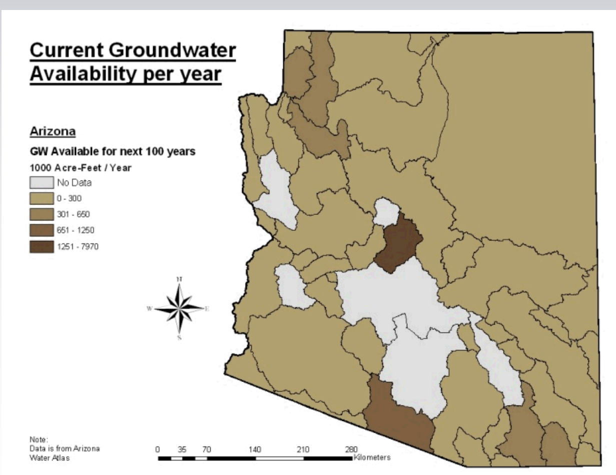
Mean Gauged Streamflo



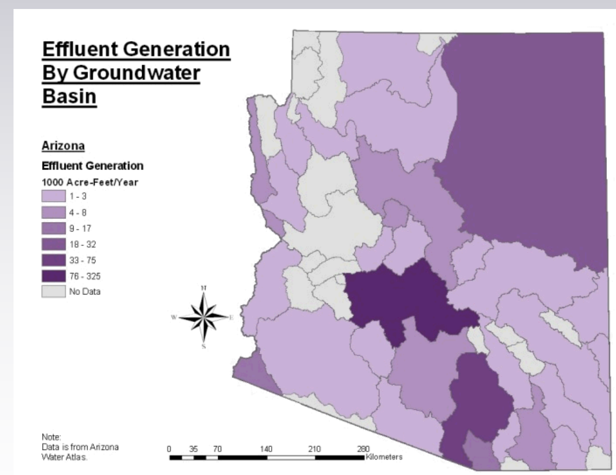
Annual Low Flow



Interbasin Transfers

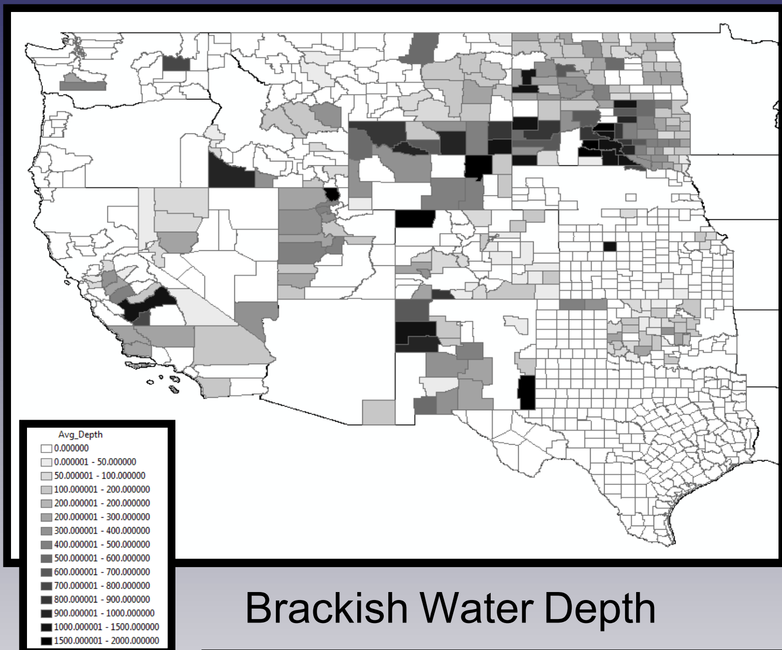


Non-Tributary Groundwater

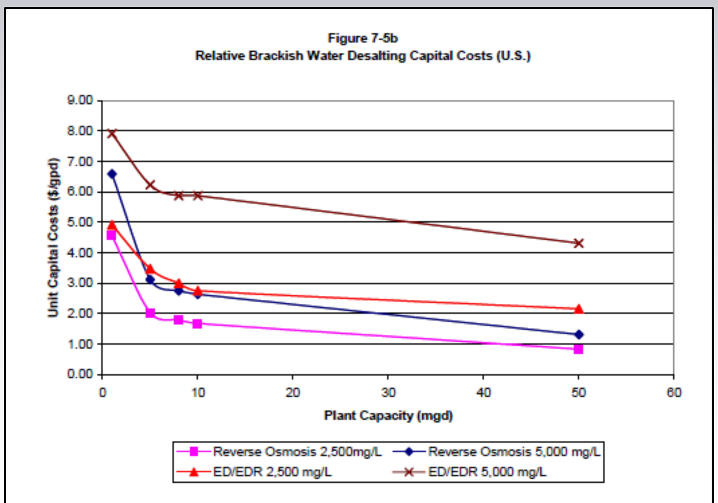


Accessible Non-Potable Sources

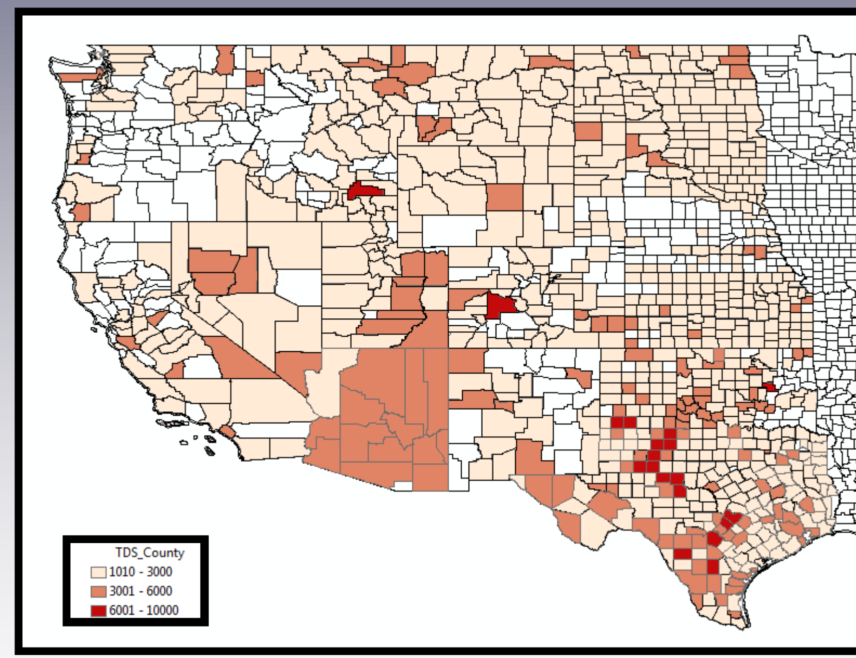
Water Availability Indicators: Supply



Brackish Water Depth



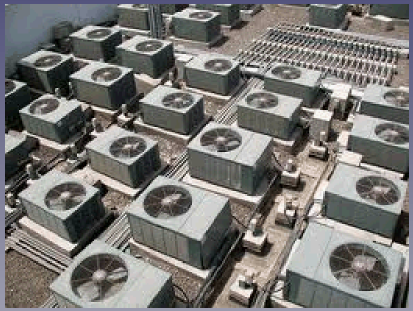
Brackish Water Treatment



Brackish TDS Levels

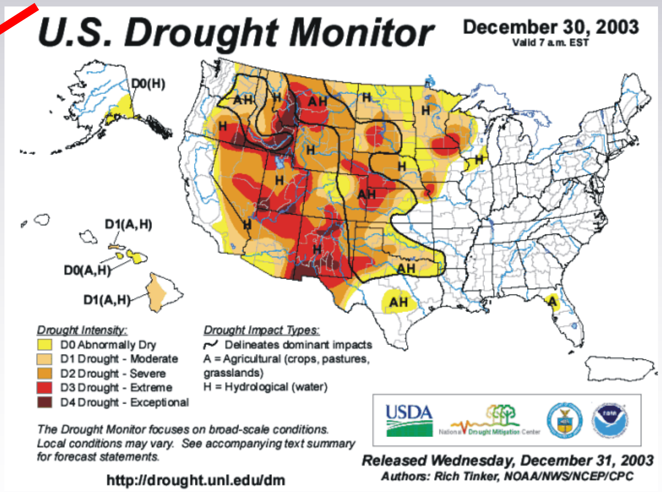
Water Availability Indicators: Drought Vulnerability

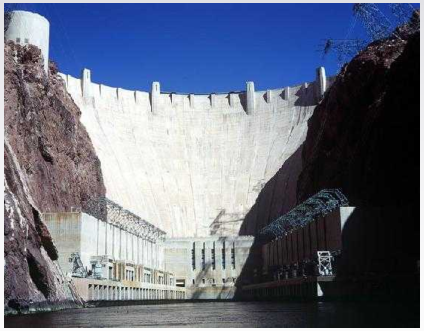
Plant Vulnerabilities
- Physical factors,
- Water rights,
- Environmental constraints



Increased Power Demand

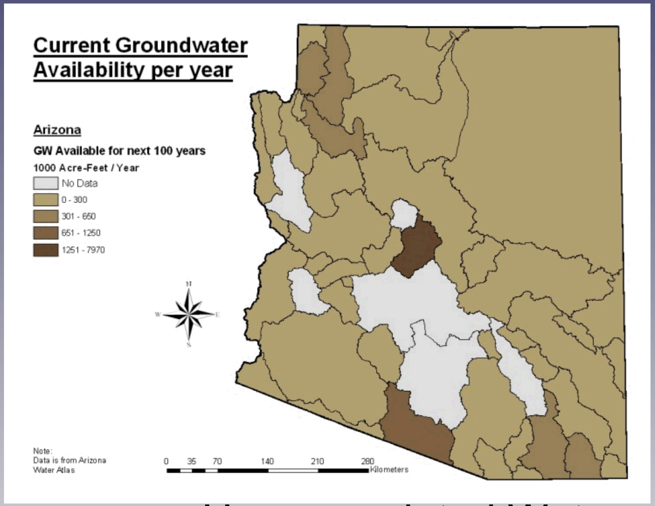
Reduced Streamflow
Reduced Supply



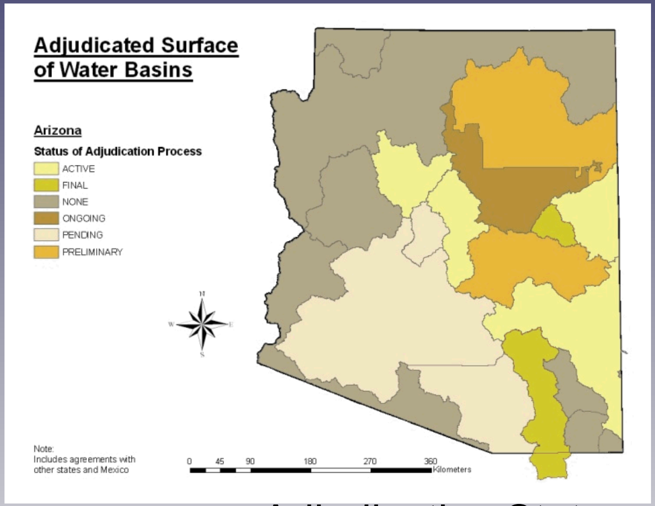


Decreased Hydropower Production

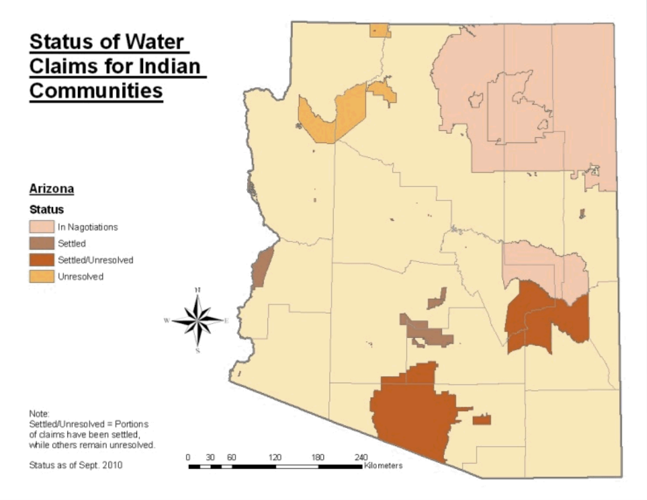
Water Availability Indicators: Institutional Factors



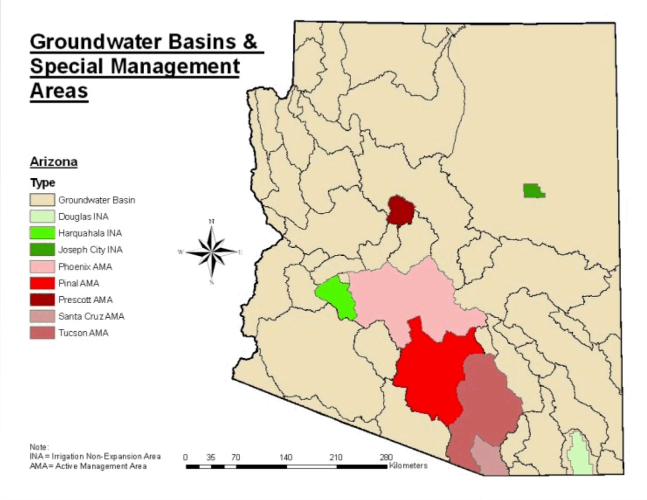
Unappropriated Water



Adjudication Status



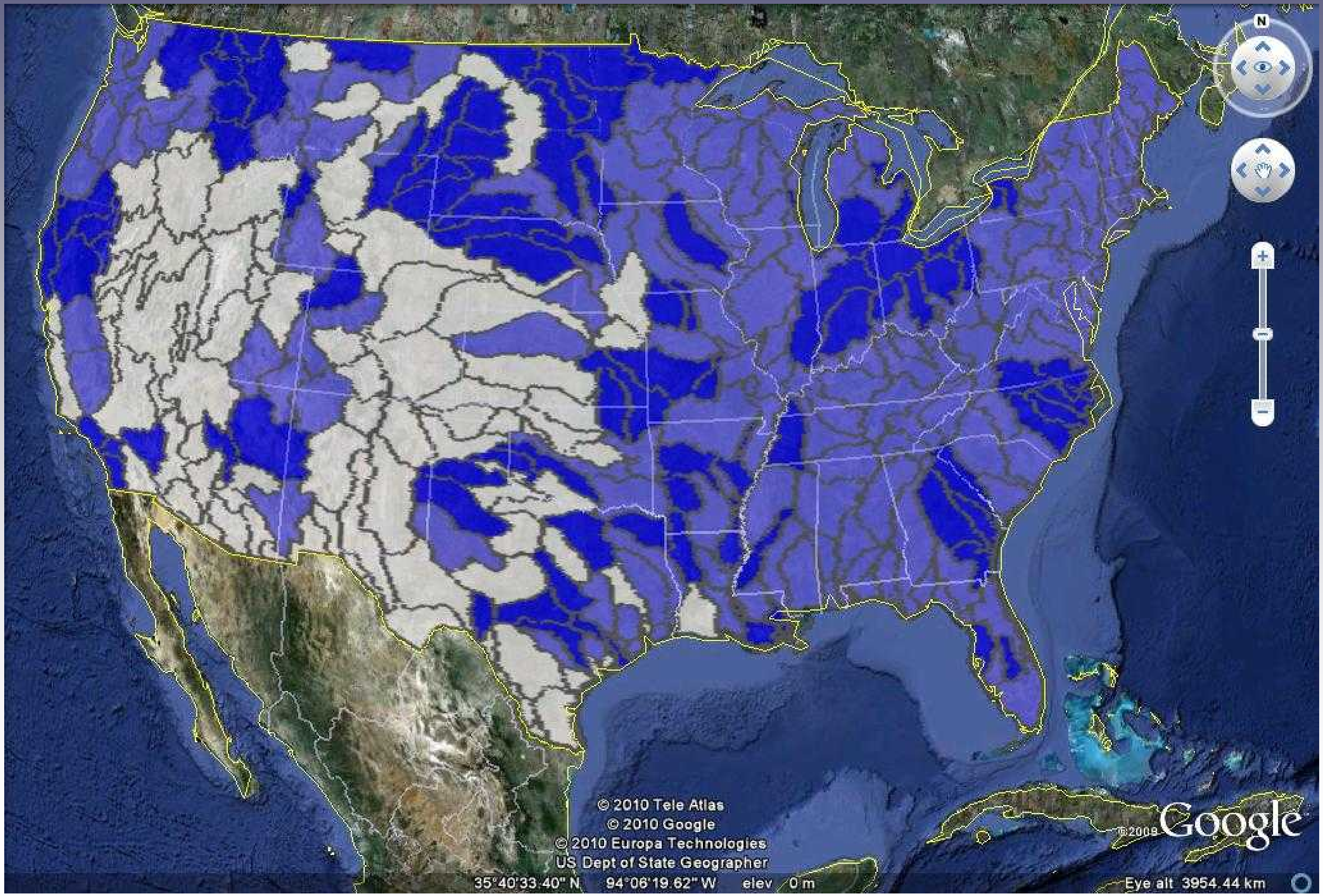
Indian Water



Administrative Control Areas

Water Availability: Environmental Flows

Ratio of Mean Stream Flow to Environmental Flow Requirements: 2004



Mean Flow / Env. Flow

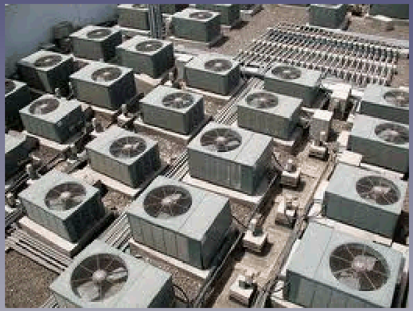
<1

1-1.25

>1.25

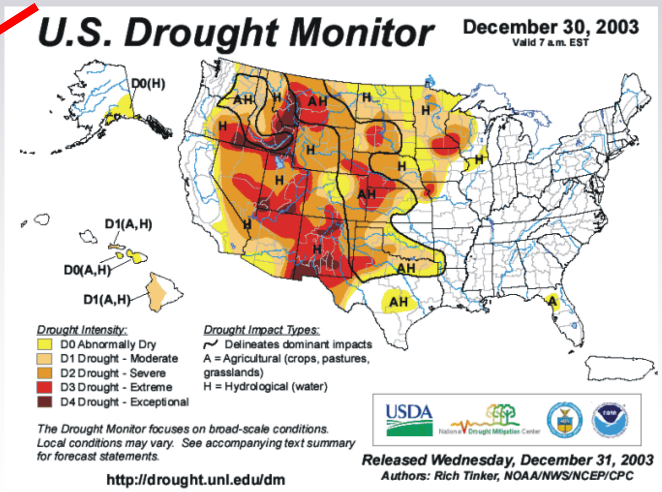
Water Availability Indicators: Drought Vulnerability

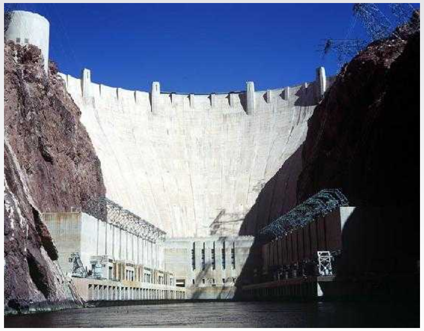
Plant Vulnerabilities
- Physical factors,
- Water rights,
- Environmental constraints



Increased Power Demand

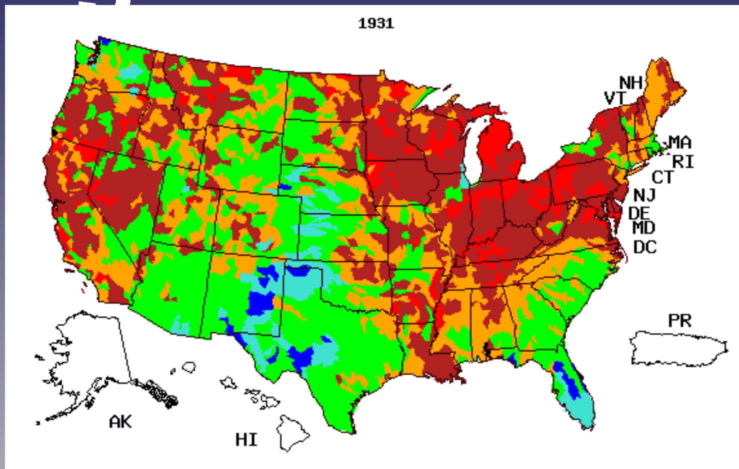
Reduced Streamflow
Reduced Supply

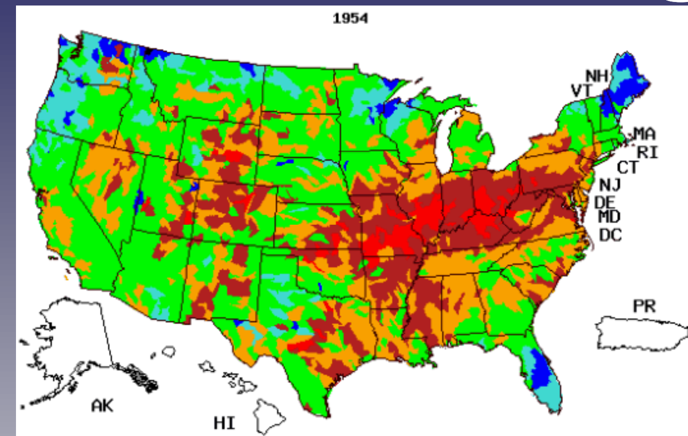


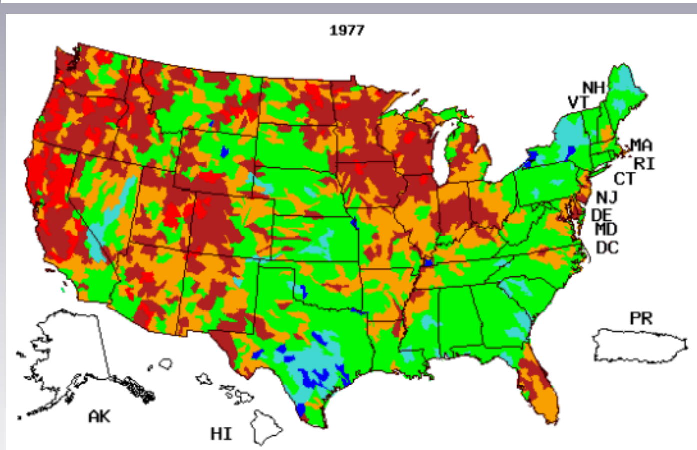


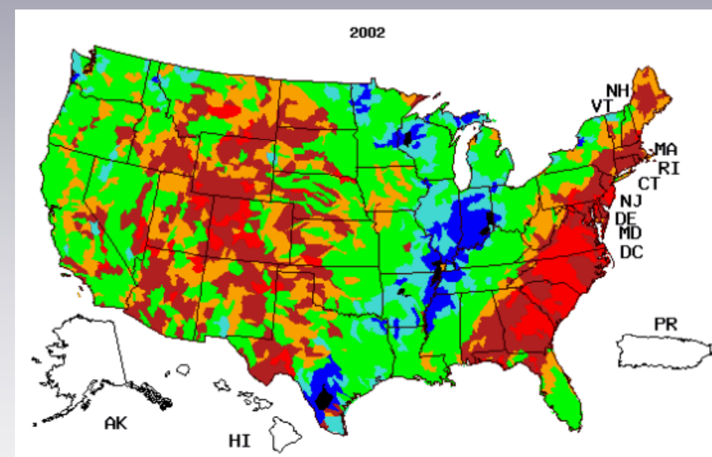
Decreased Hydropower Production

Regional Pattern of Severe Drought







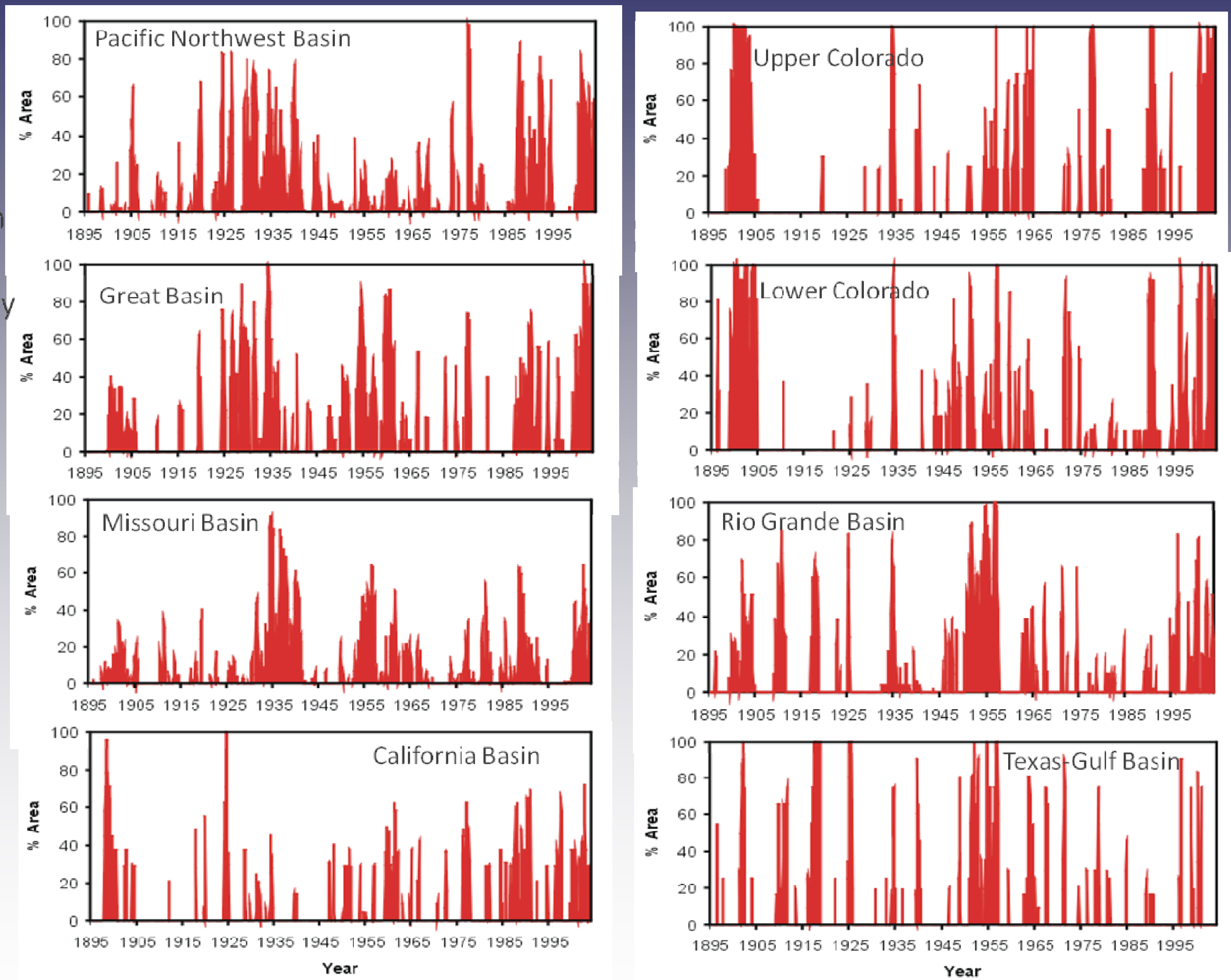


Explanation -- Percentile Range							
Lowest	< 10	10 - 24	25 - 75	76 - 90	>90	Highest	No data

Eugene Yan, May 2011

Regional Pattern of Severe Drought

Long duration
Low frequency

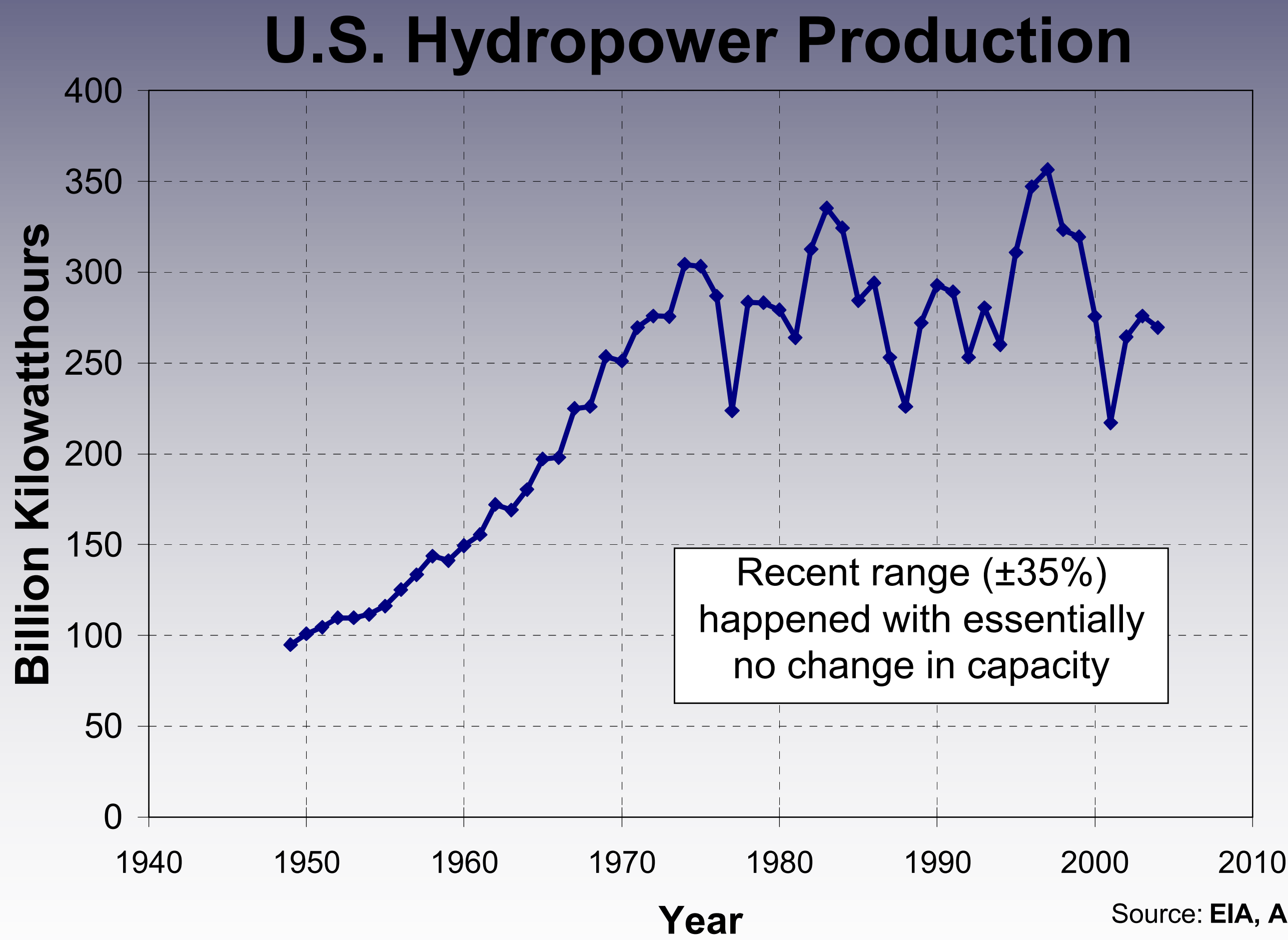


Short
duration
High
frequency

Eugene Yan for Drought Analysis Progress Report, May 19, 2011

National Drought Mitigation Center 2006

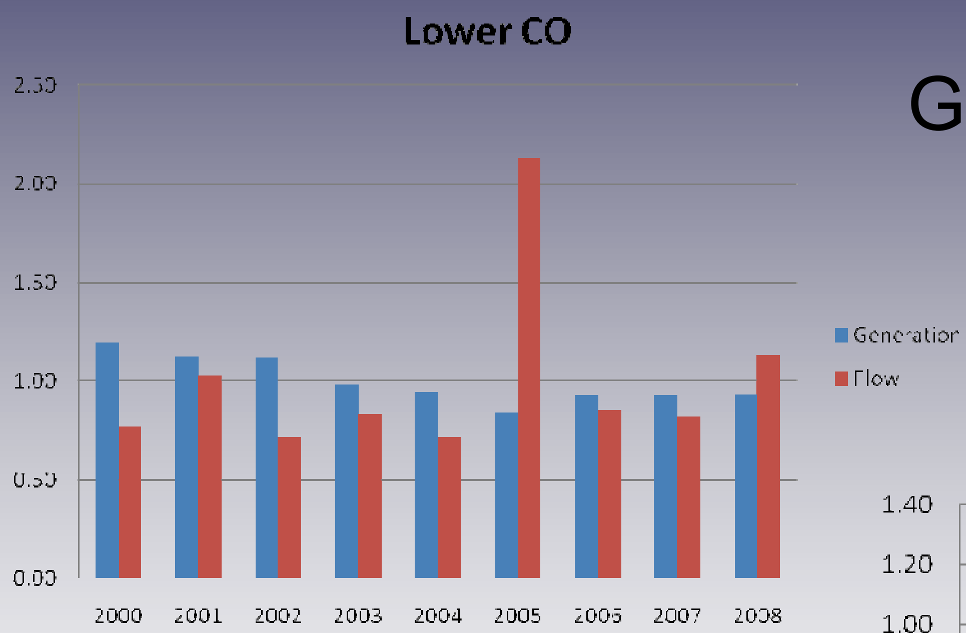
Hydroelectric Power at Risk of Drought



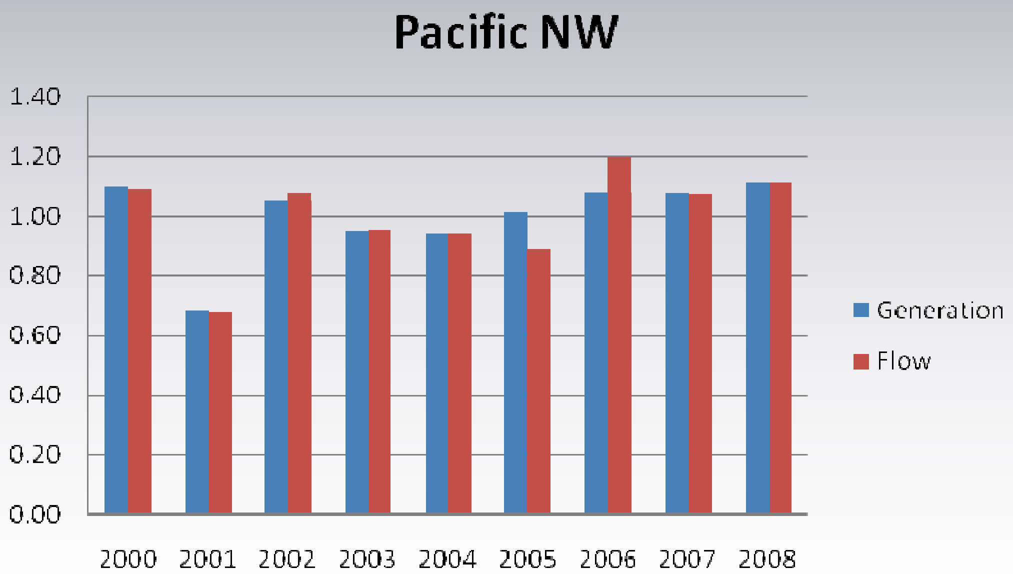
- Supplies 6%-10% of US electricity

Source: **EIA, Annual Energy Review, 2005**

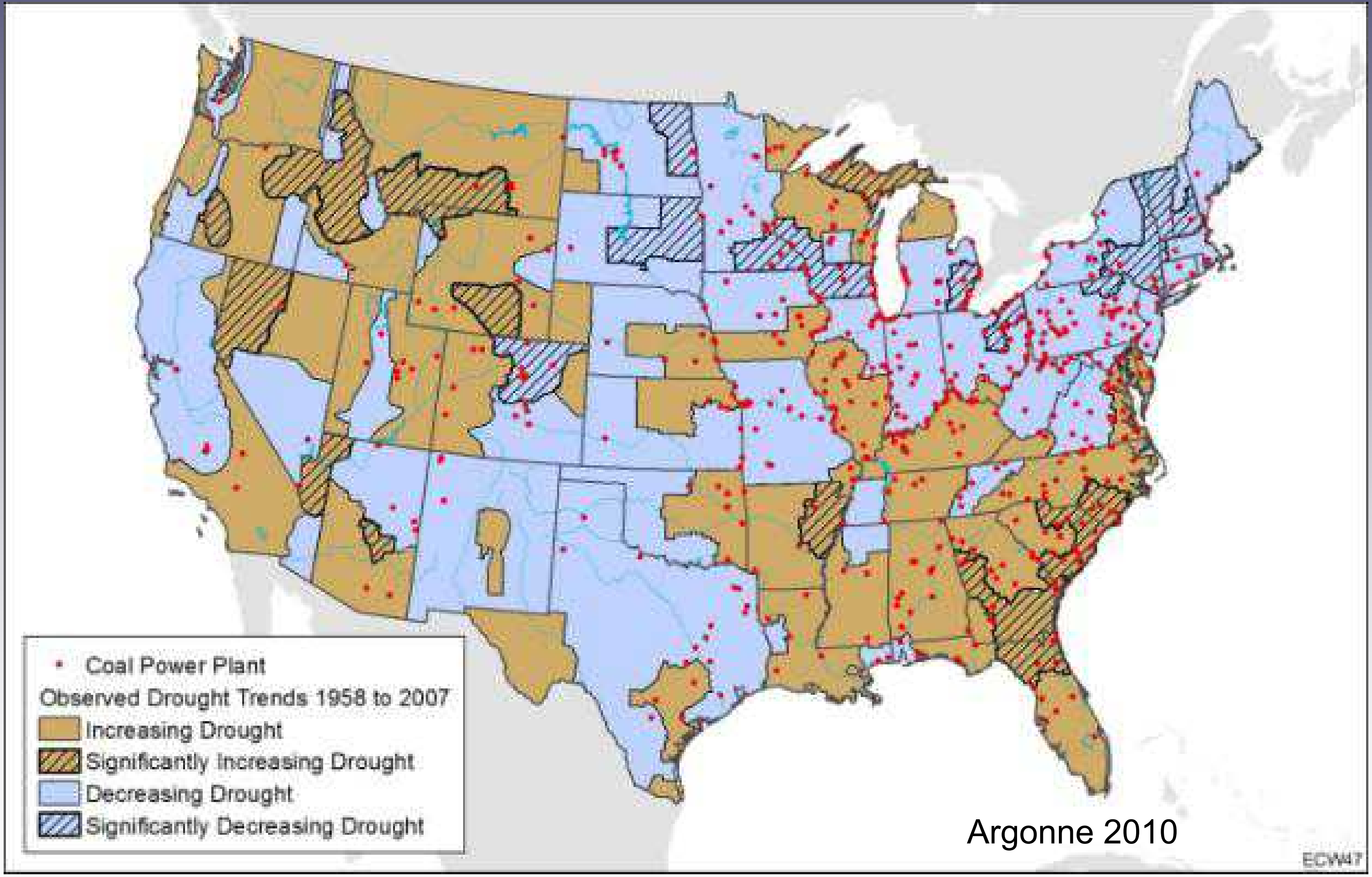
Hydroelectric Power at Risk of Drought



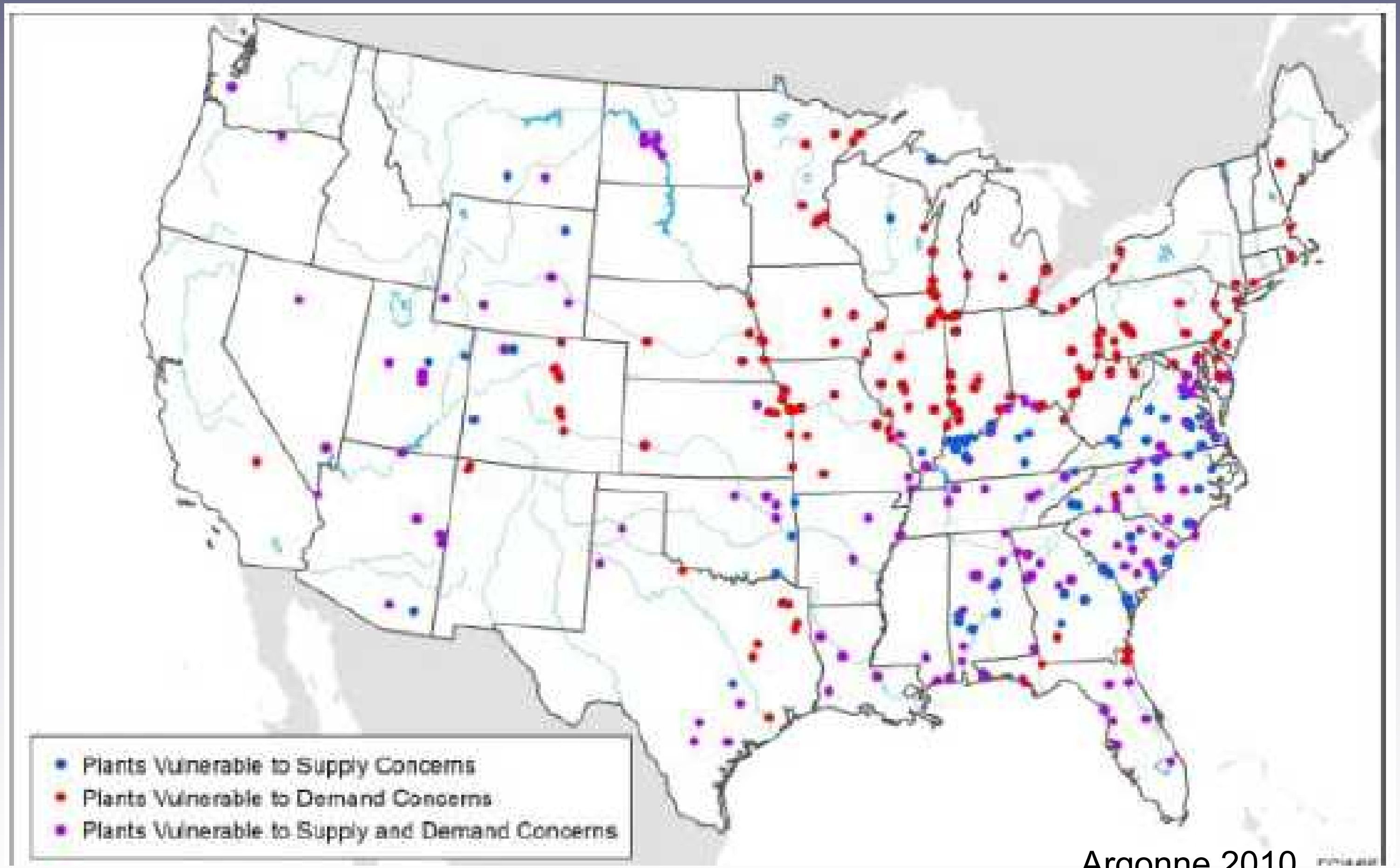
Generation vs. Streamflow for different basins



Thermoelectric Power at Risk of Drought



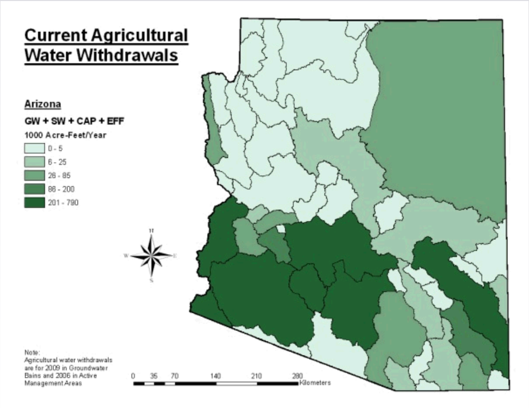
Thermoelectric Power at Risk of Drought



Argonne 2010

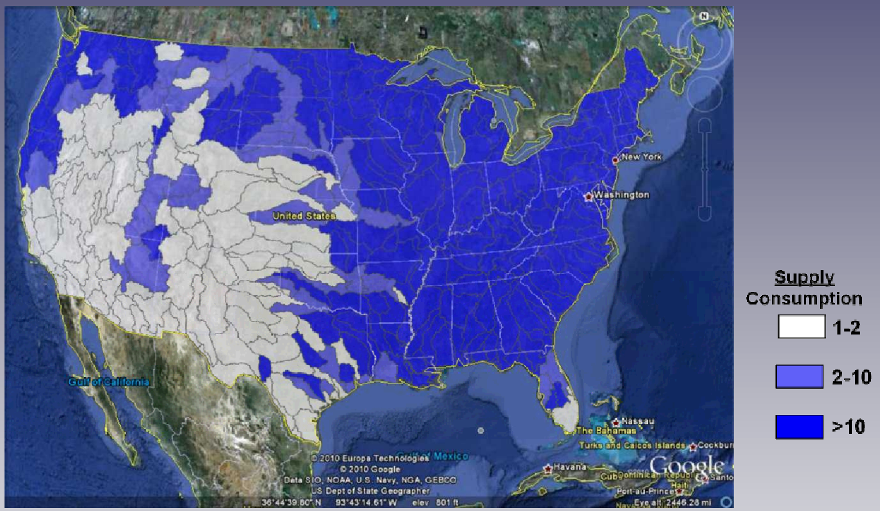
Water Availability Indicators: Value of Water

- Historic value of leased and sold water rights
- Economic value of water
- Cost of backstop technology

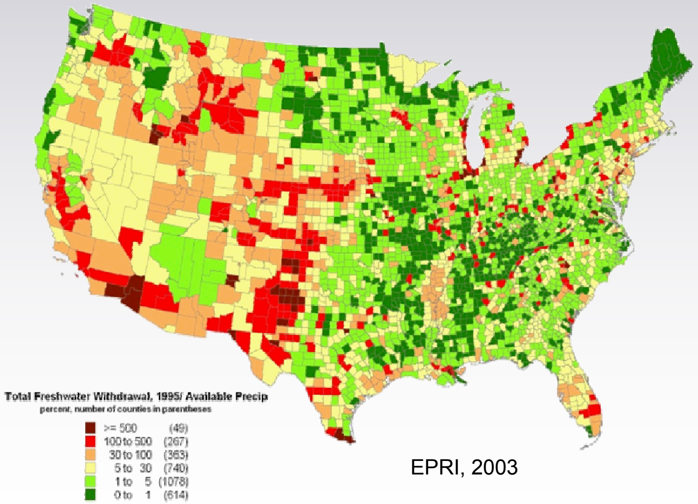


Water Availability Indicators

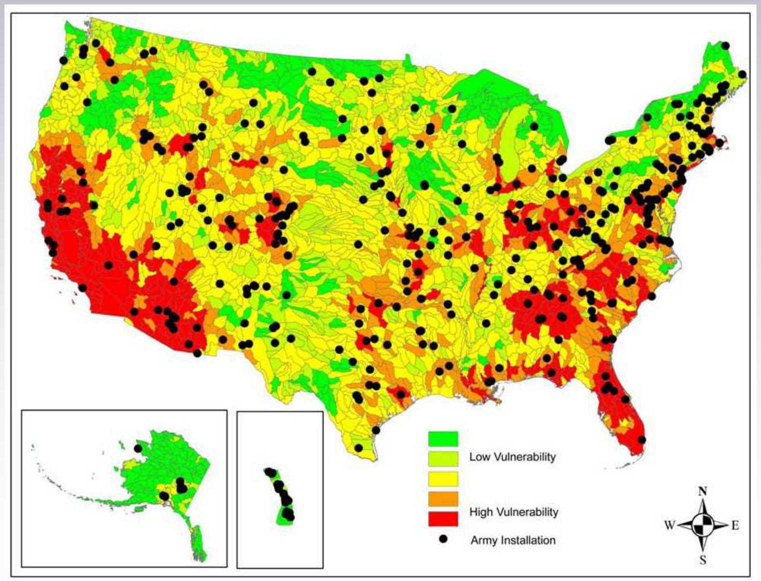
Ratio of Mean Stream Flow to Total Water Consumption:2004



- No perfect metric
- Need to develop consensus metric(s)
- Propose to establish a working group



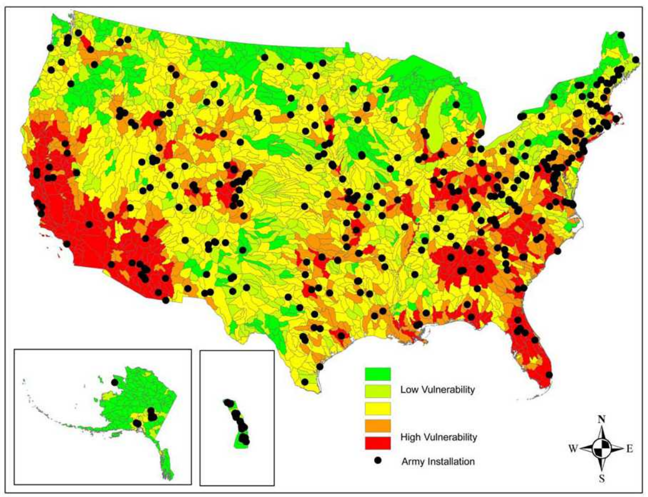
EPRI, 2003



USACE, 2009

Summary

- Proposed general matrix of water availability indicators:
  - ***Water Demand***
  - ***Water Supply***
  - ***Drought Vulnerability***
  - ***Institutional Factors***
  - ***Value of Water***



- Request support in developing a set of “consensus metrics” for use in interconnection wide transmission planning

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Albuquerque, NM 87185
(505)844-6025
vctidwe@sandia.gov

More Information at:

www.sandia.gov/mission/energy/arra/energy-water.html