Water Risk Management in the Electric Power Sector

Robert Goldstein (rogoldst@epri.com)
Senior Technical Executive, Water and Ecosystems

Jessica Shi (jshi@epri.com)

Technical Lead, Technology Innovation Water Conservation Program

American Association of Blacks in Energy

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Topics

- Status and trends in water withdrawals
- Projections of water withdrawals through 2030
- Decision support water resource risk management (Water Prism)
- Water use reduction strategies
- Potential breakthrough thermoelectric plant cooling research

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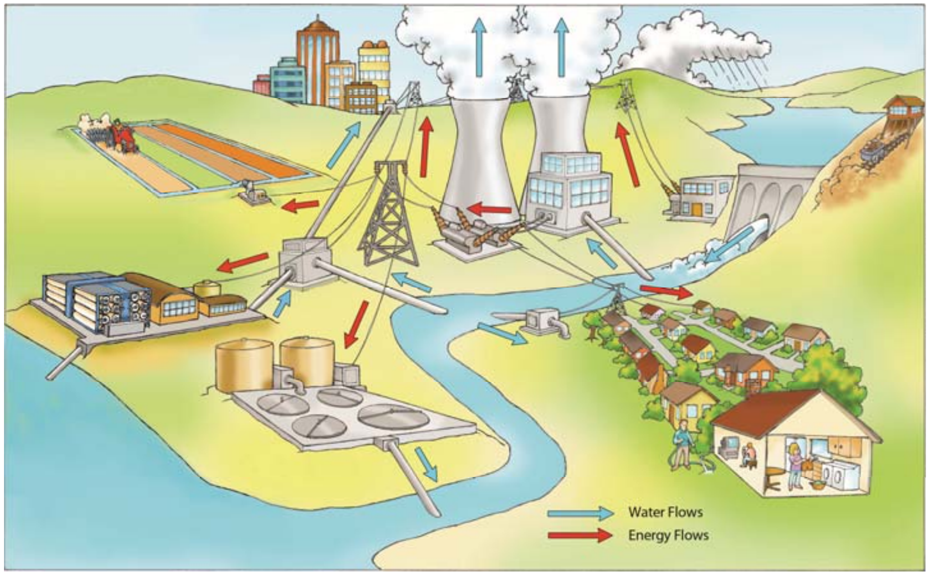
Major Themes

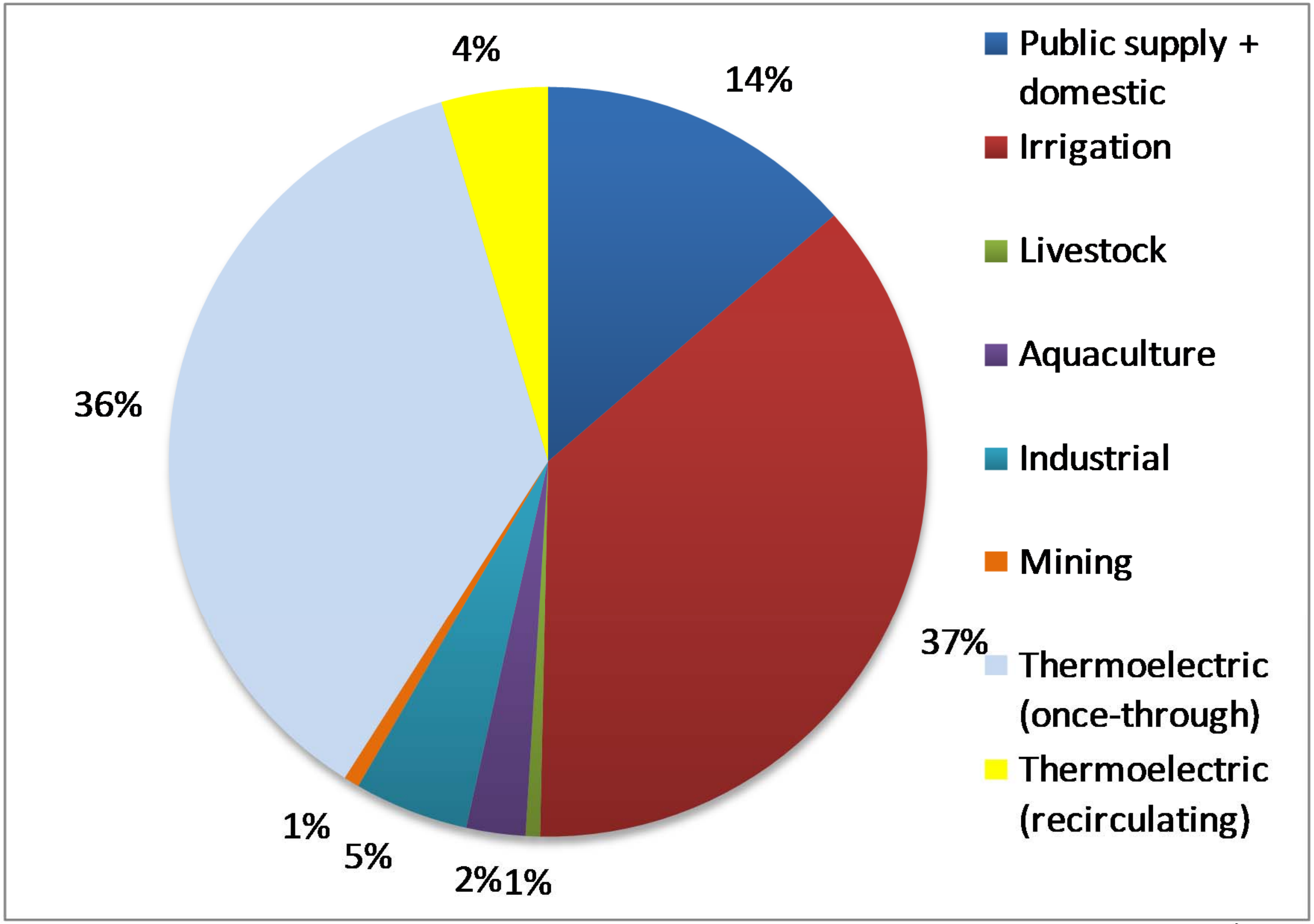
- There is no such thing as Business as Usual - everything is evolving with time
- Everything is distributed non-uniformly in space
- Top down management is necessary for sustainability
- Need localized, fine resolution decision support tool to manage community (watershed, region) water resources
- Research can lead to promising breakthrough technologies to save water



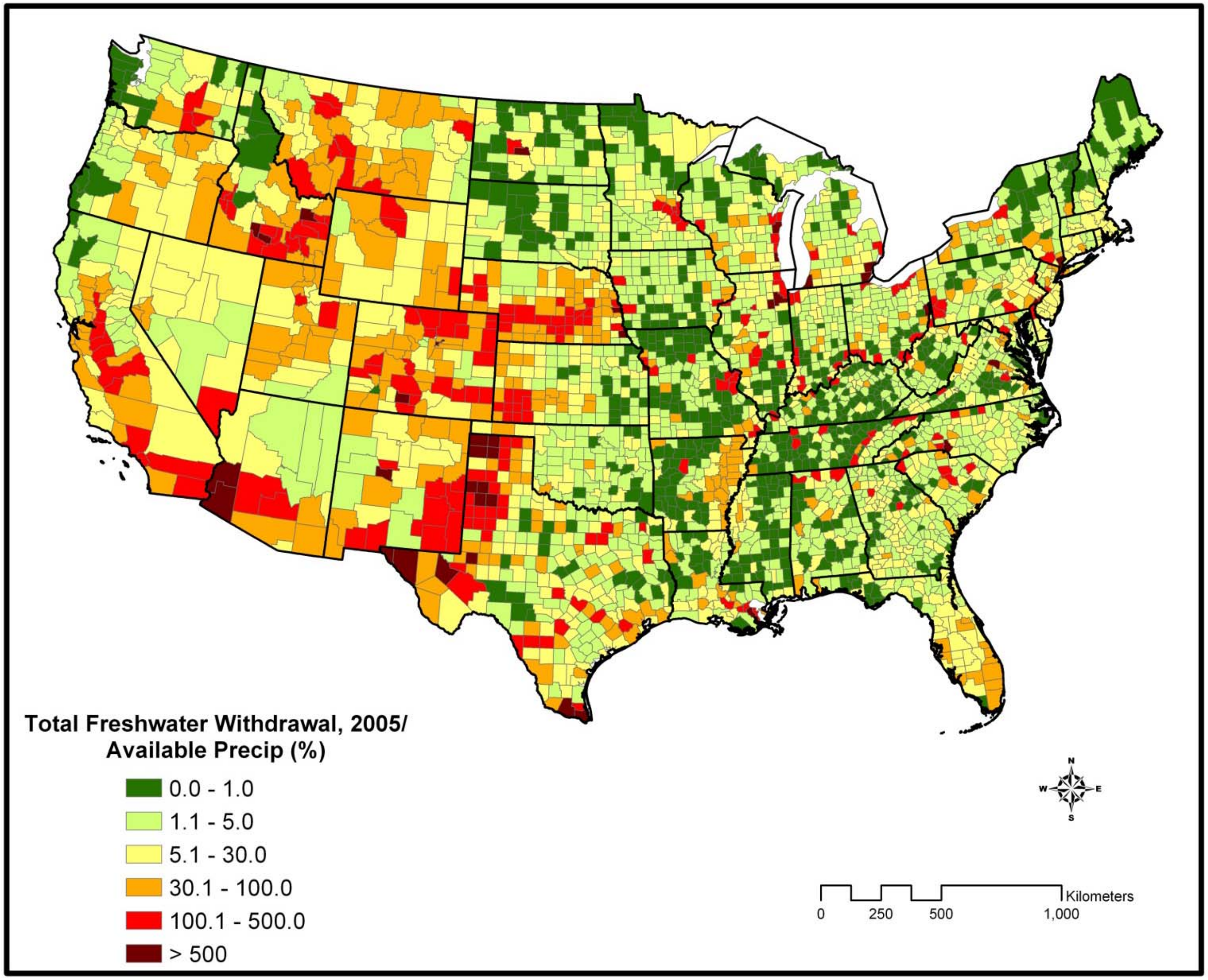
Value and Caveats: Water Withdrawal Status, Trends and Projections

- Value
  - Uses ready available internet data bases
  - Maps high level response space
  - Identifies localities of concern
  - Illustrates water using sectors' interdependencies
  - Identifies trends
- Caveats
  - Bounding or scoping analysis
  - Many interacting, nonlinear factors affecting water use
  - Many nuances and subtleties
  - Many assumptions and simplifications
  - Looks simple but is not
  - One should carefully read text before using illustrations

National Water Withdrawals (2005)
(Source: EPRI Report 1023676)



Sustainability: Total Freshwater Withdrawal (2005)/Average Available Precipitation (1934-2005)



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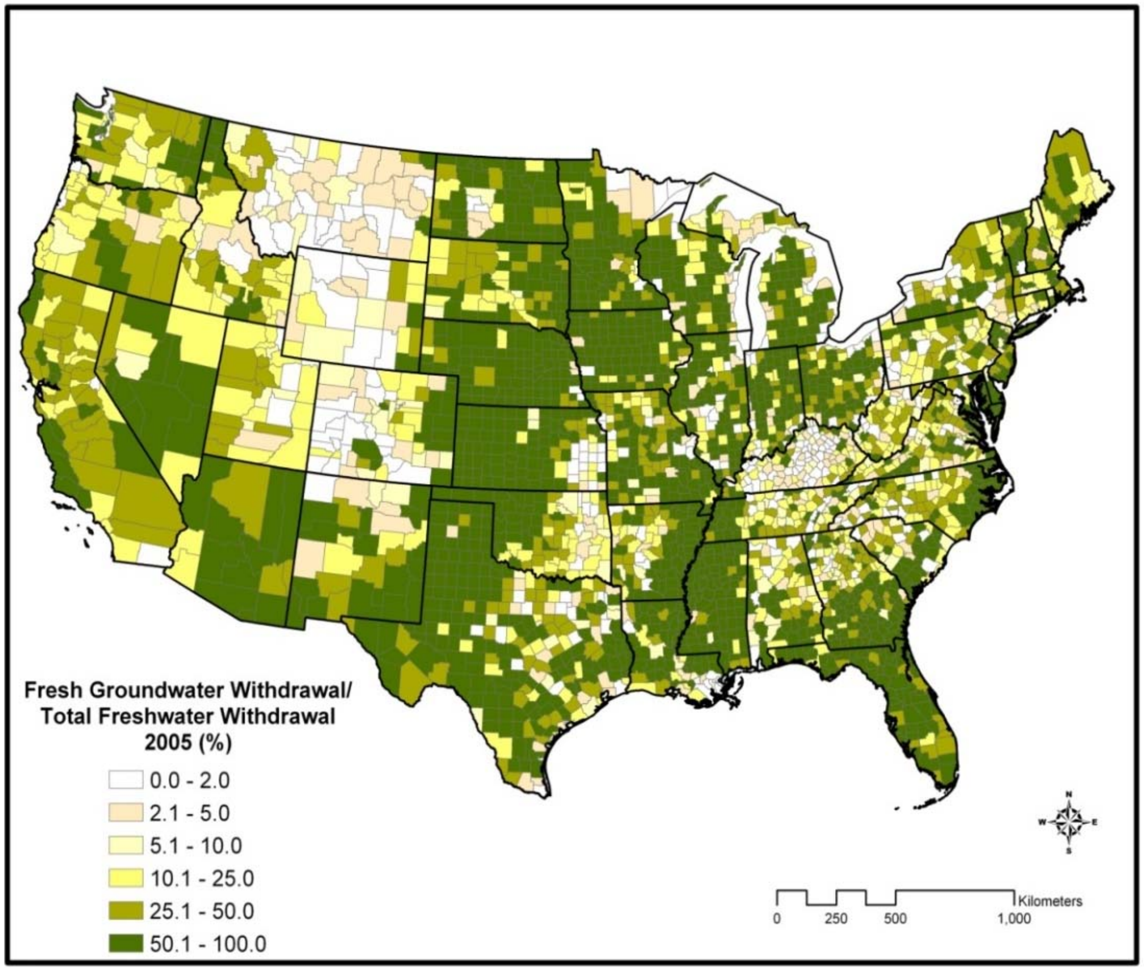
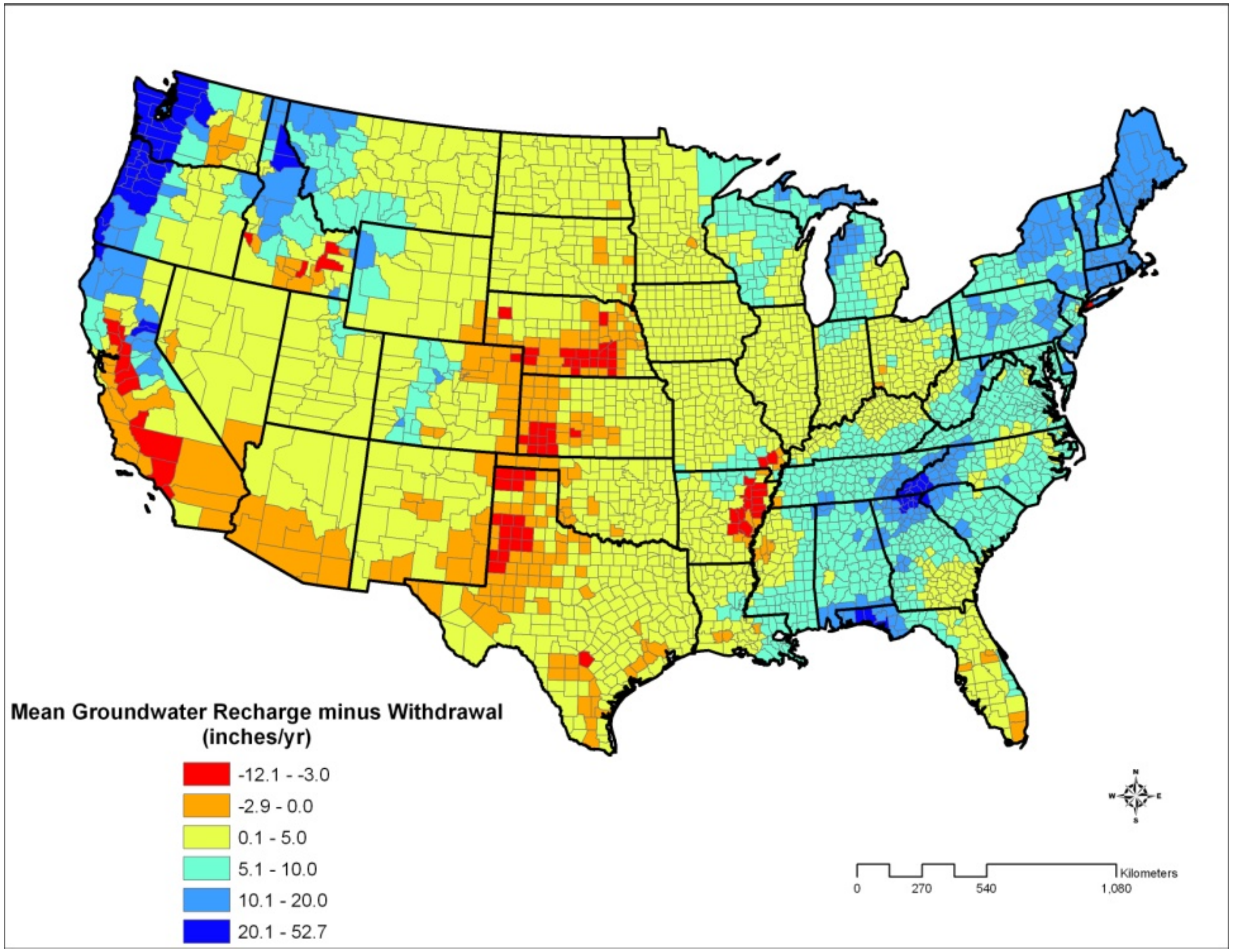
Groundwater Withdrawal/Total Freshwater Withdrawal (2005)



Mean Groundwater Recharge Minus Withdrawal (2005)



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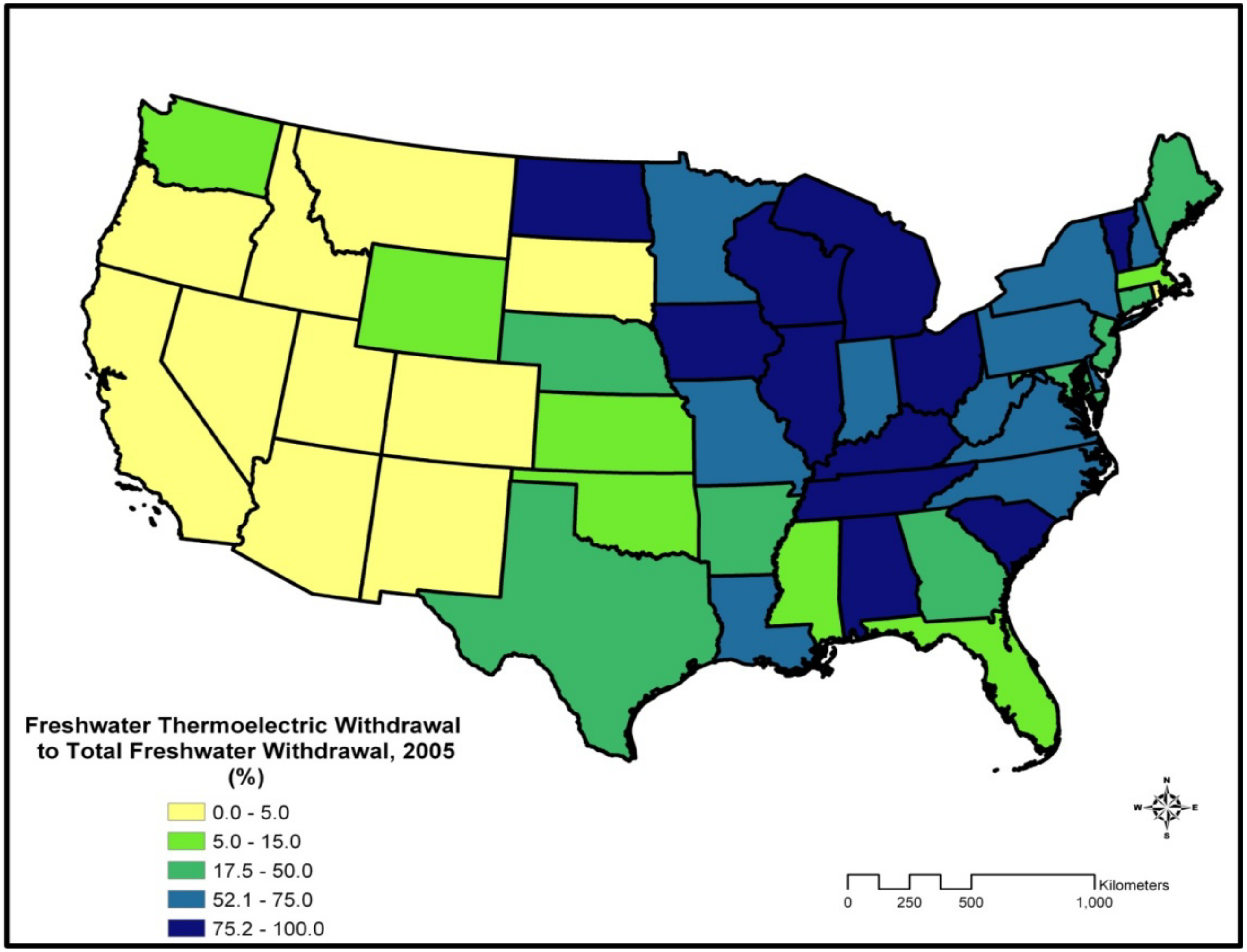
Freshwater Thermoelectric Withdrawal as a Percentage of Total Freshwater Withdrawal (2005)



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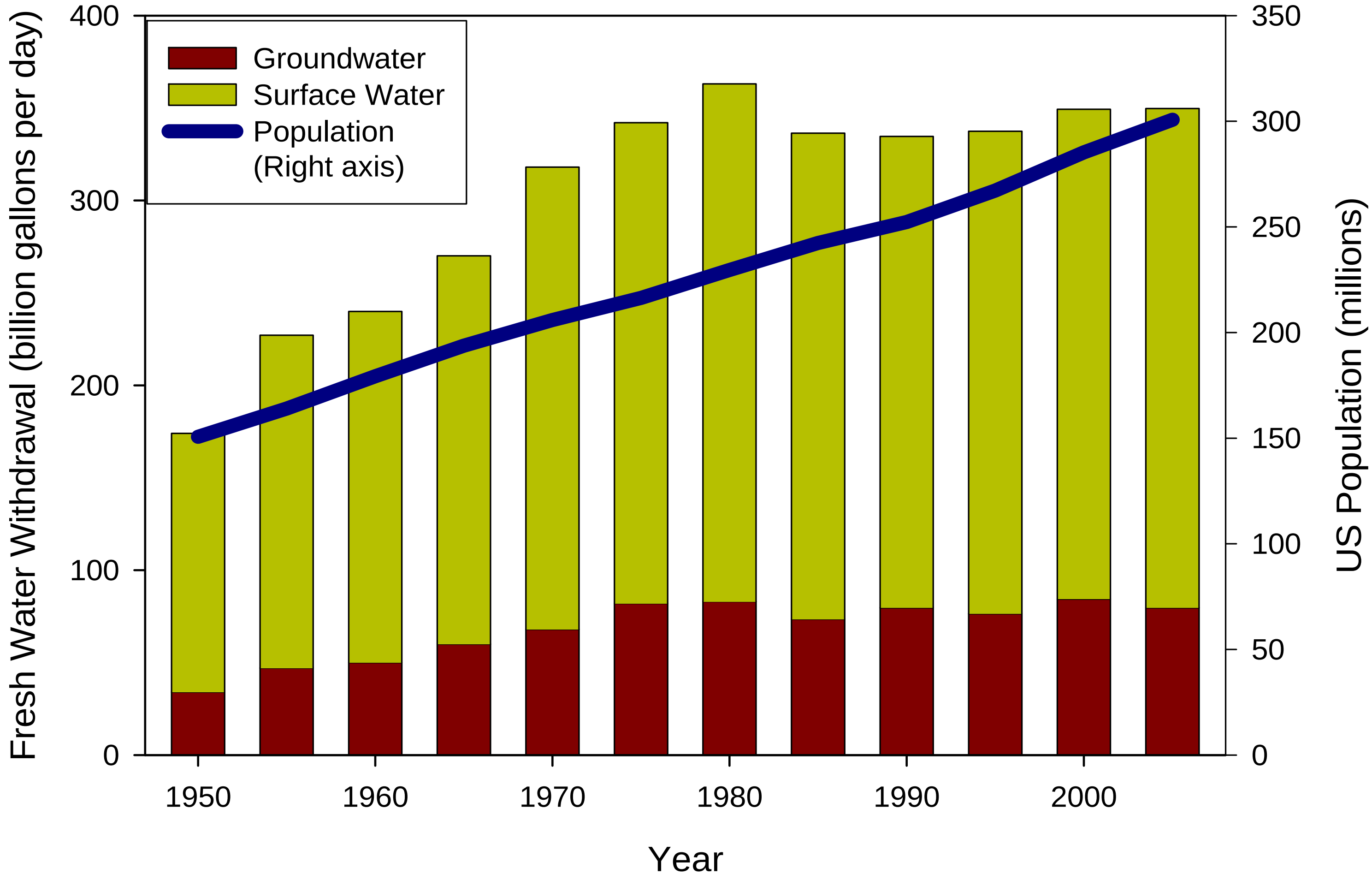
National Freshwater Withdrawals by Year



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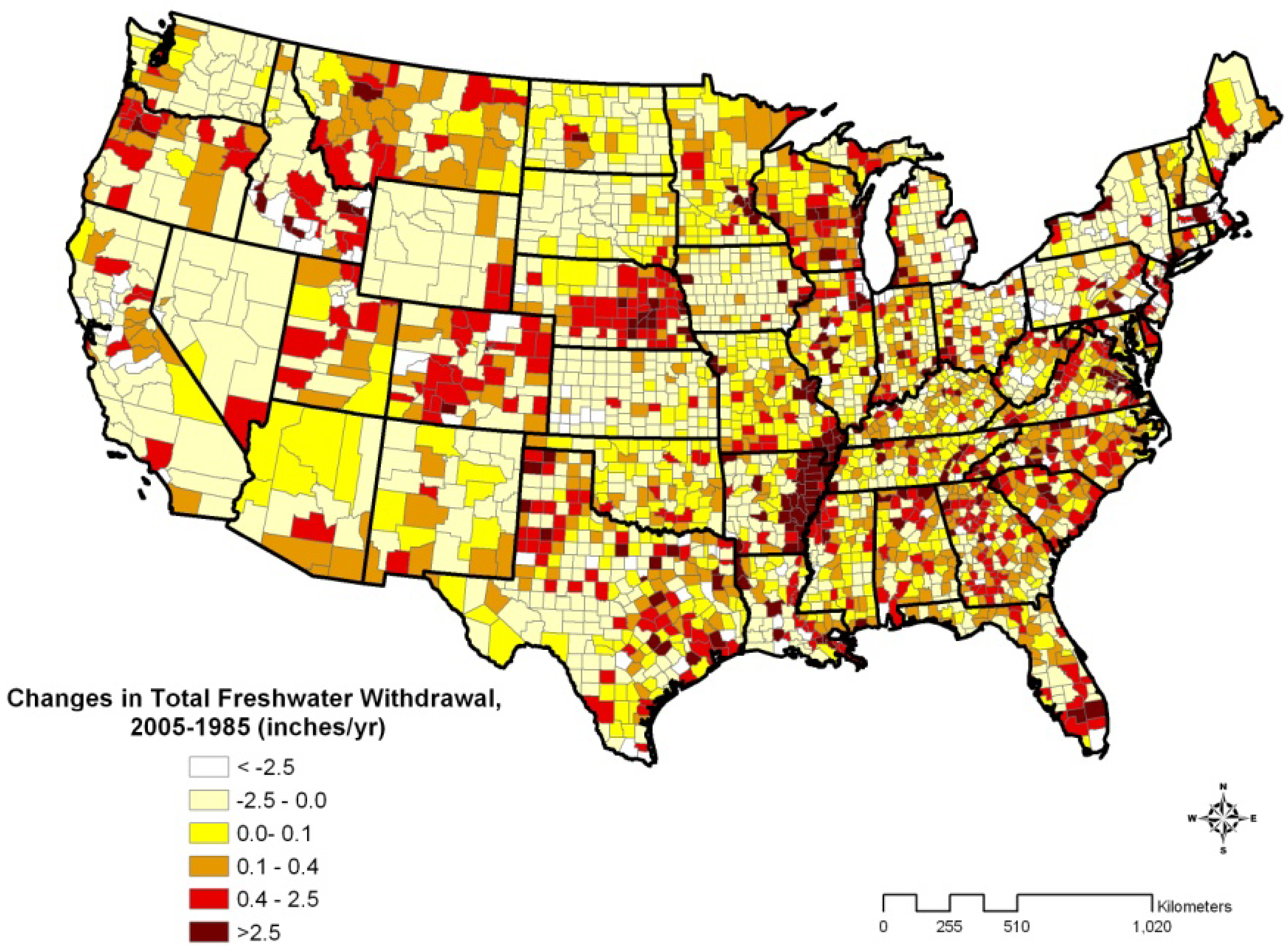
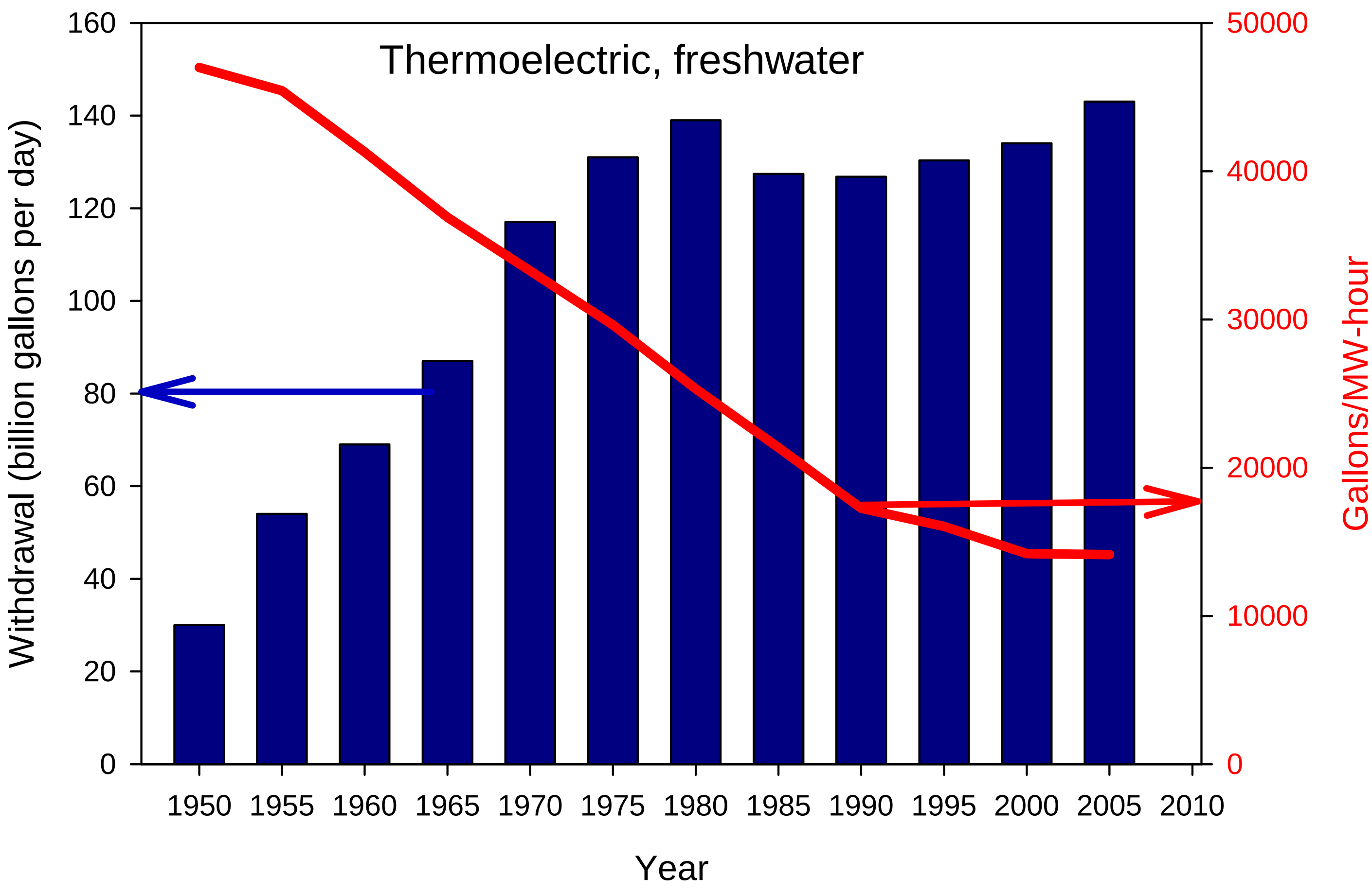
Change in Freshwater Withdrawal 2005-1985



Trend in Thermoelectric Water Withdrawals



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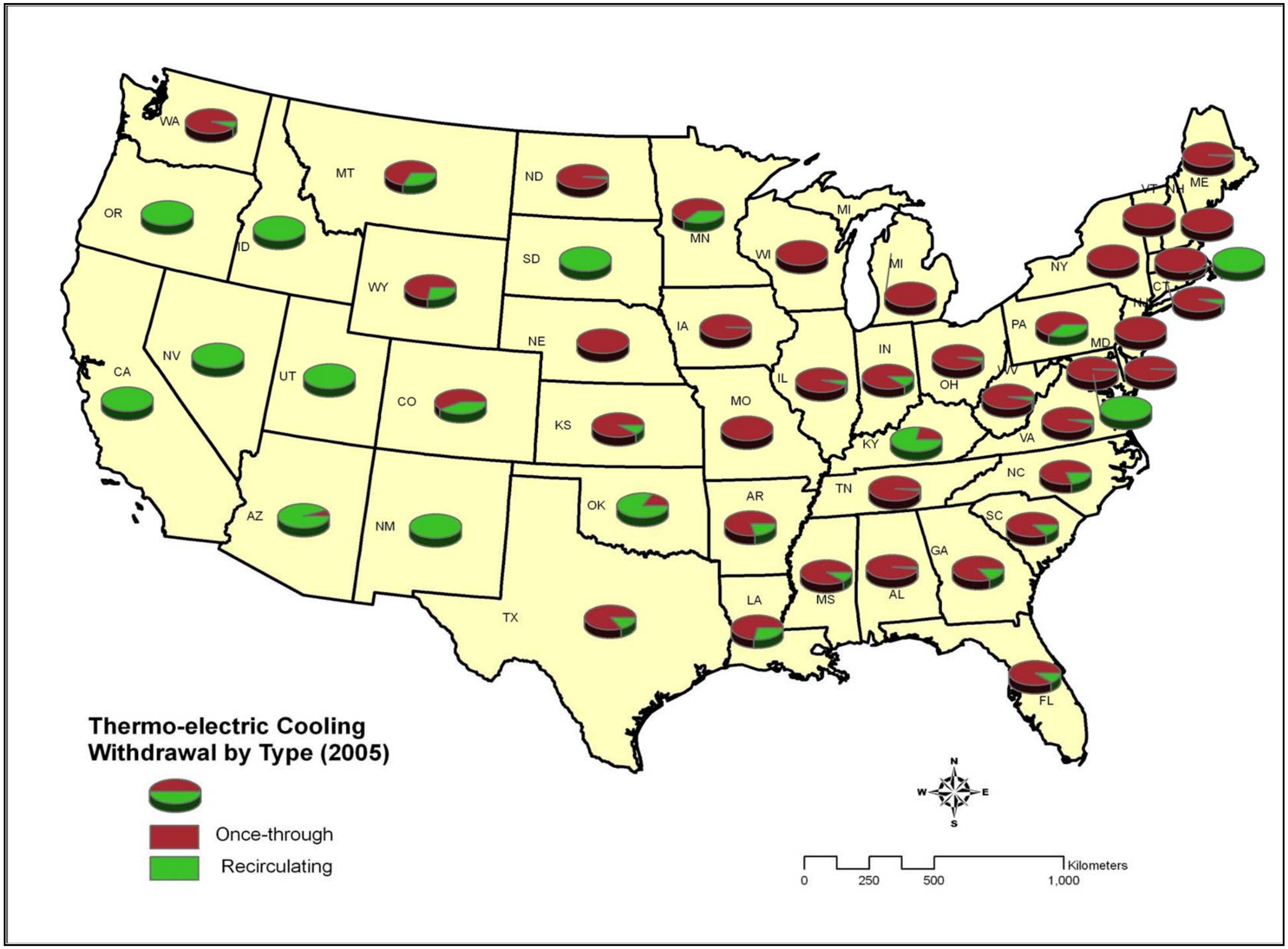
Freshwater Thermoelectric Cooling by Type of Cooling System (2005-1985)



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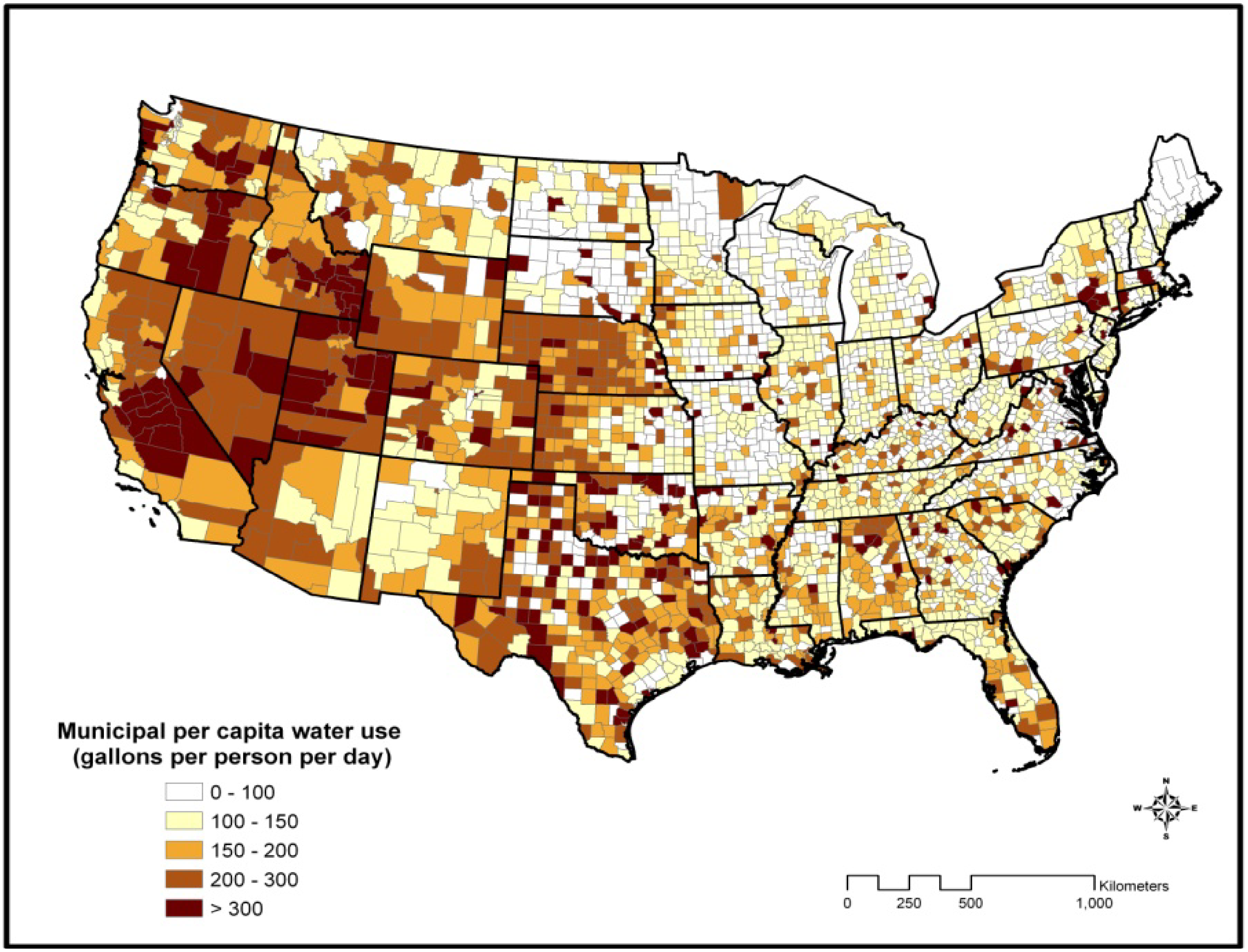
Municipal Per Capita Water Withdrawal (2005)



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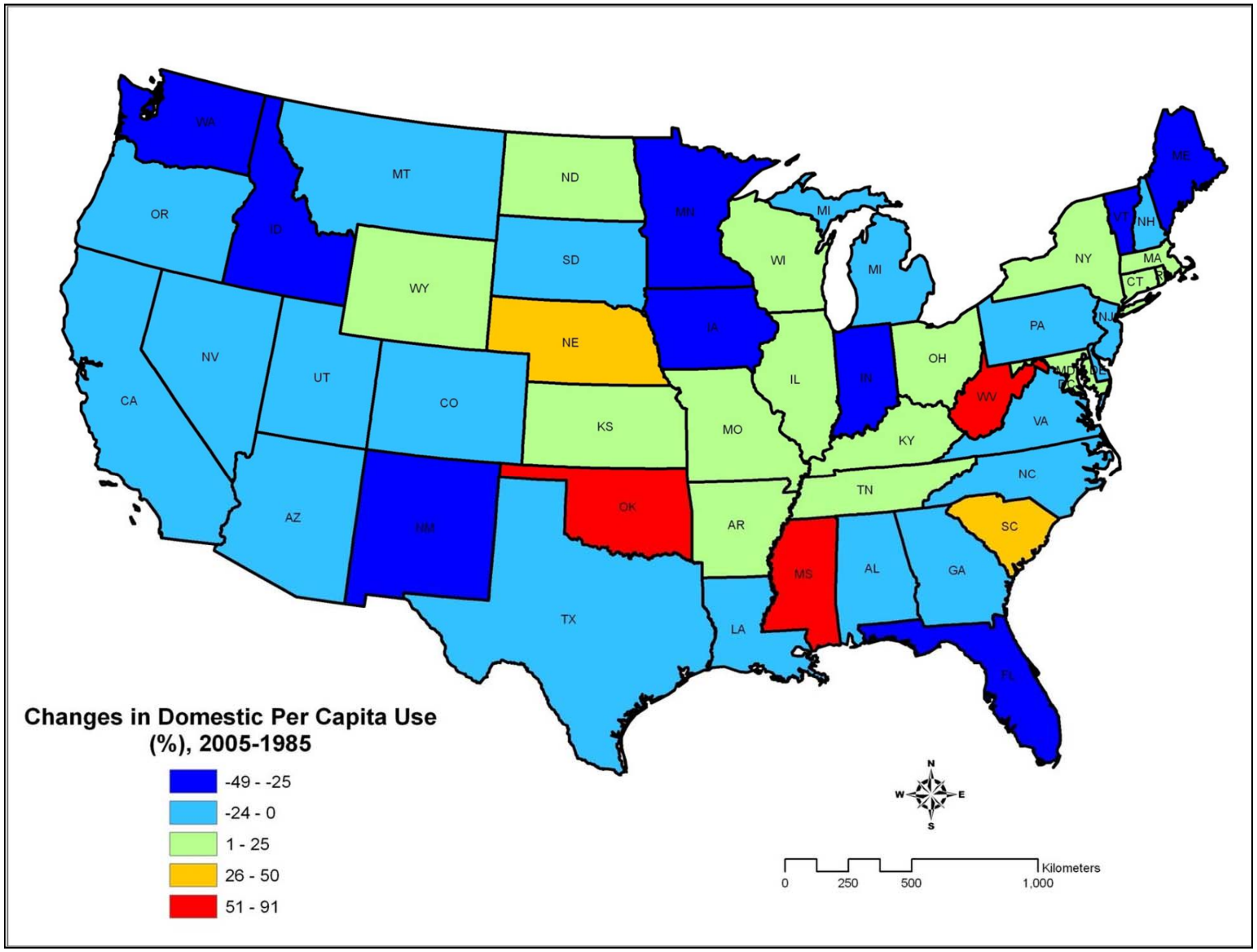
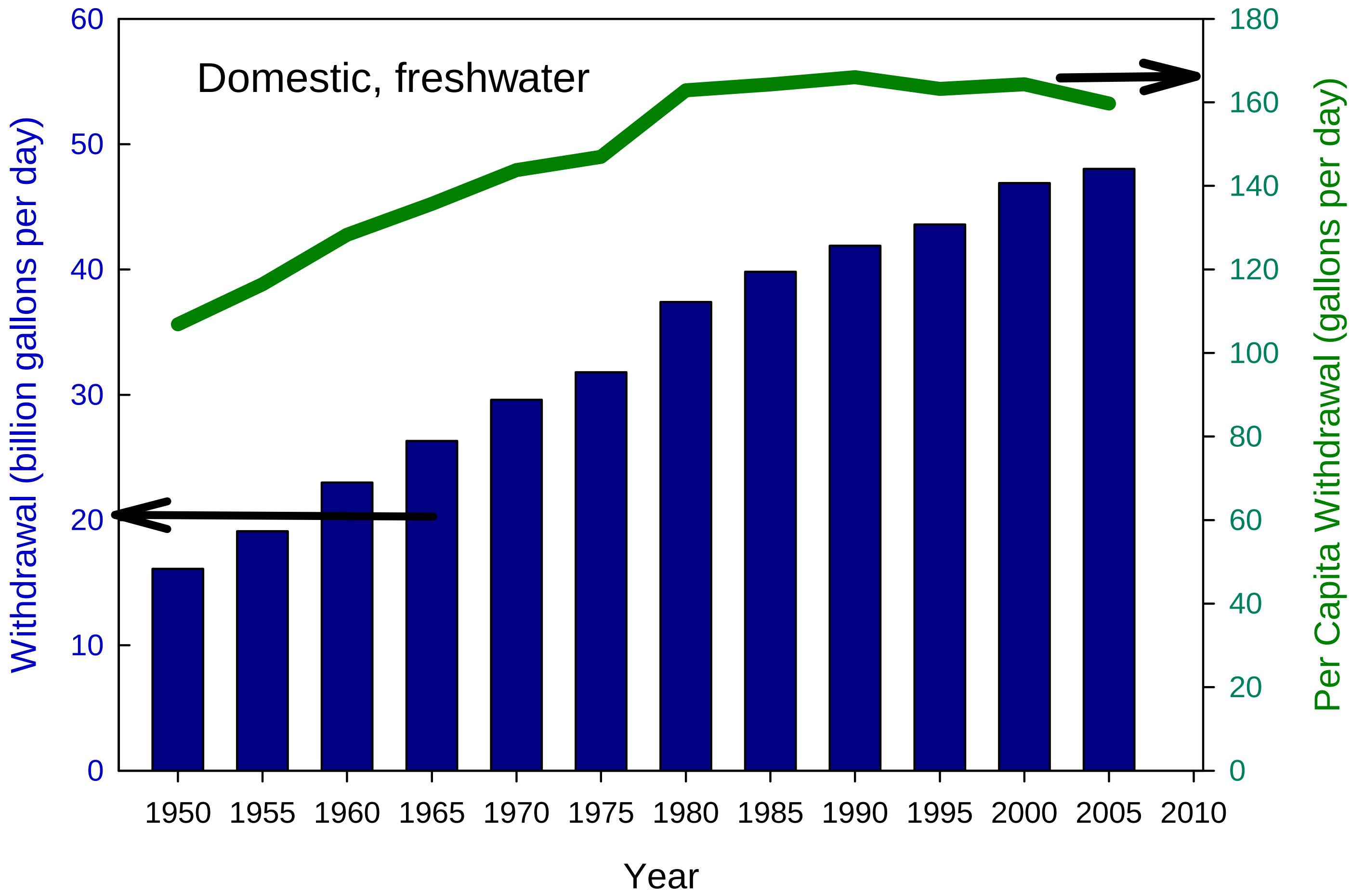
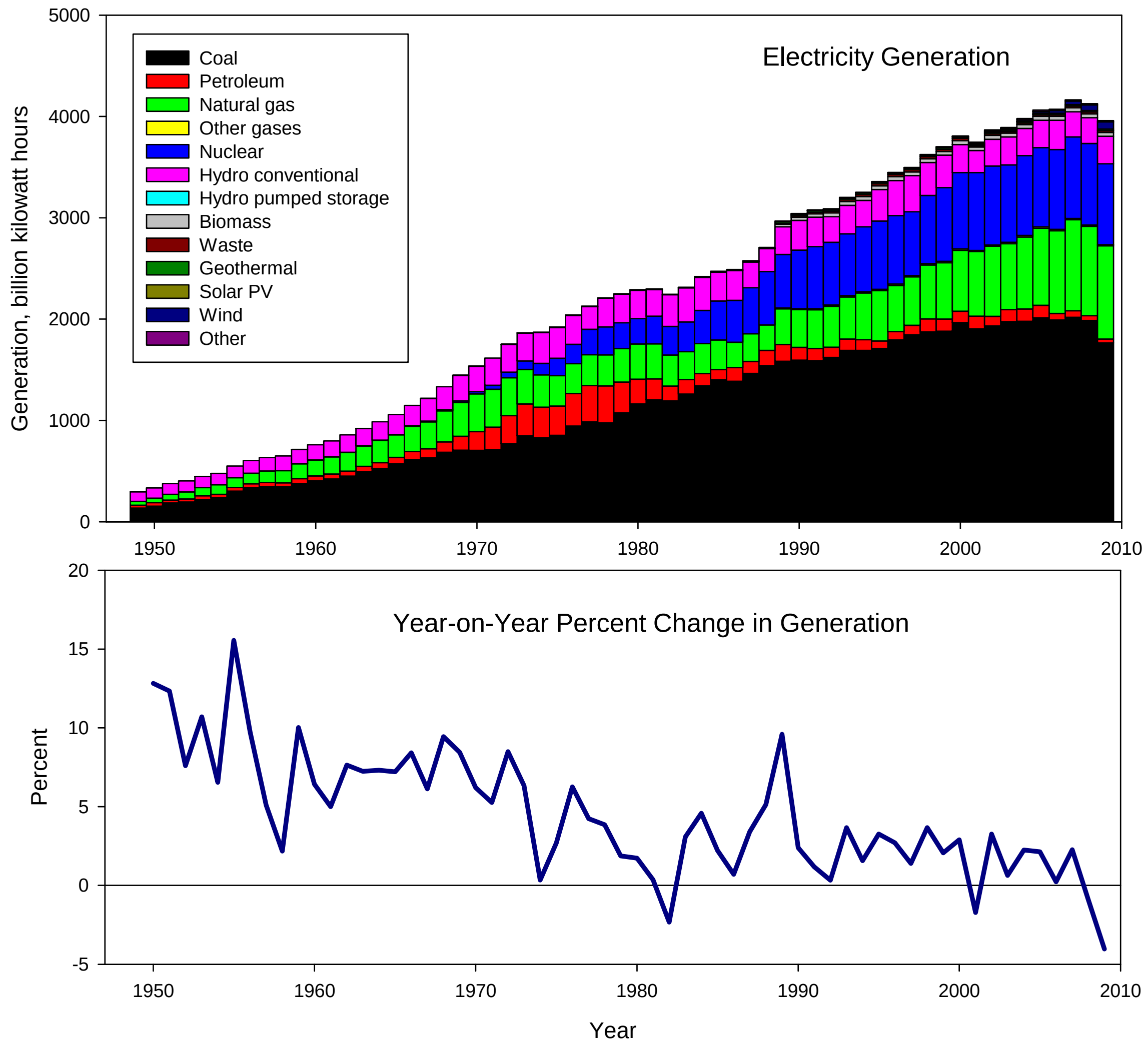
Change is Municipal Per Capita Withdrawal



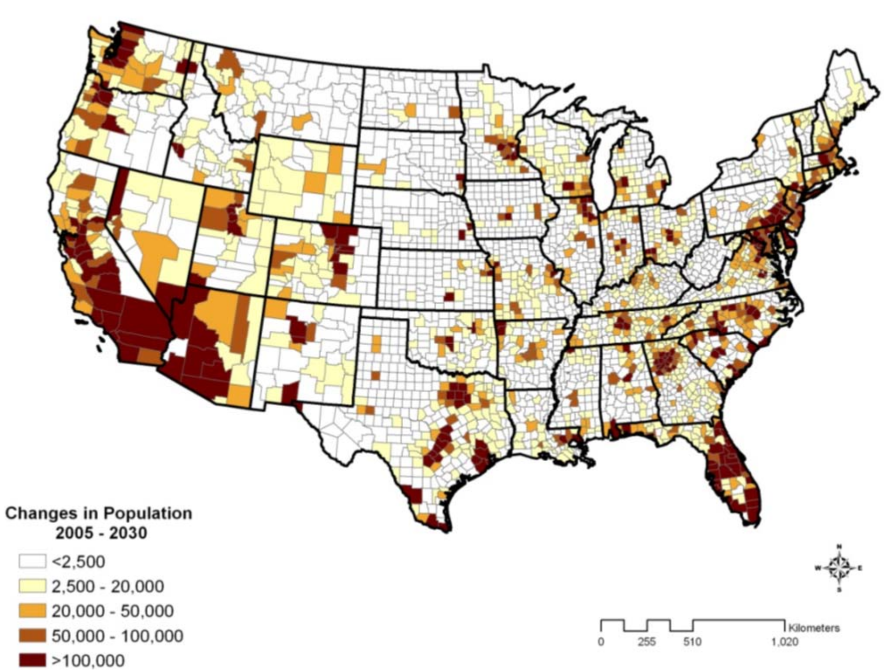
Trend in Domestic Freshwater Withdrawal

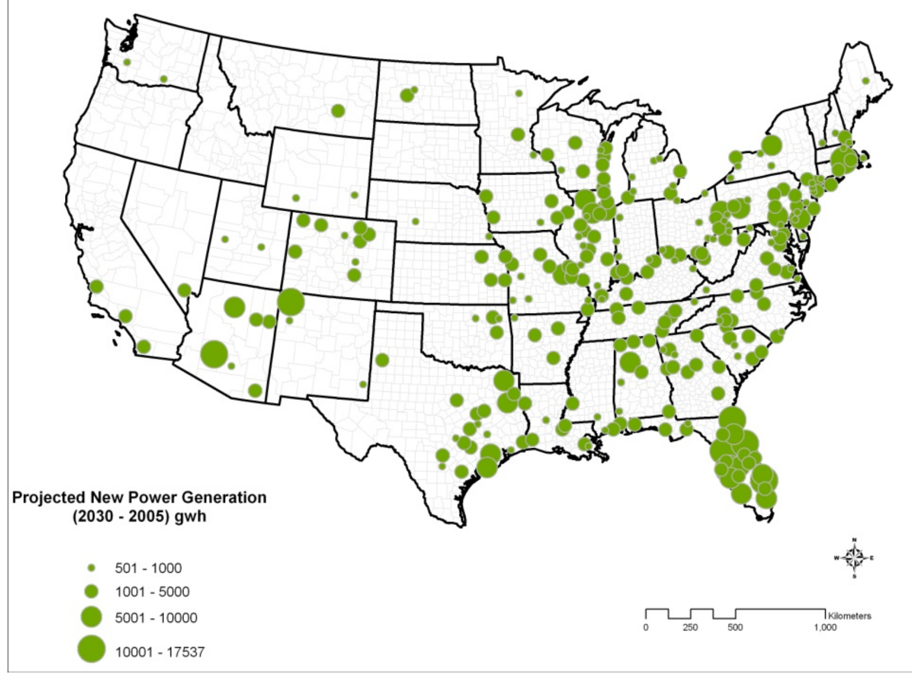


National Electricity Generation by Year



Projected Population and Power Generation Growth (2030-2005)





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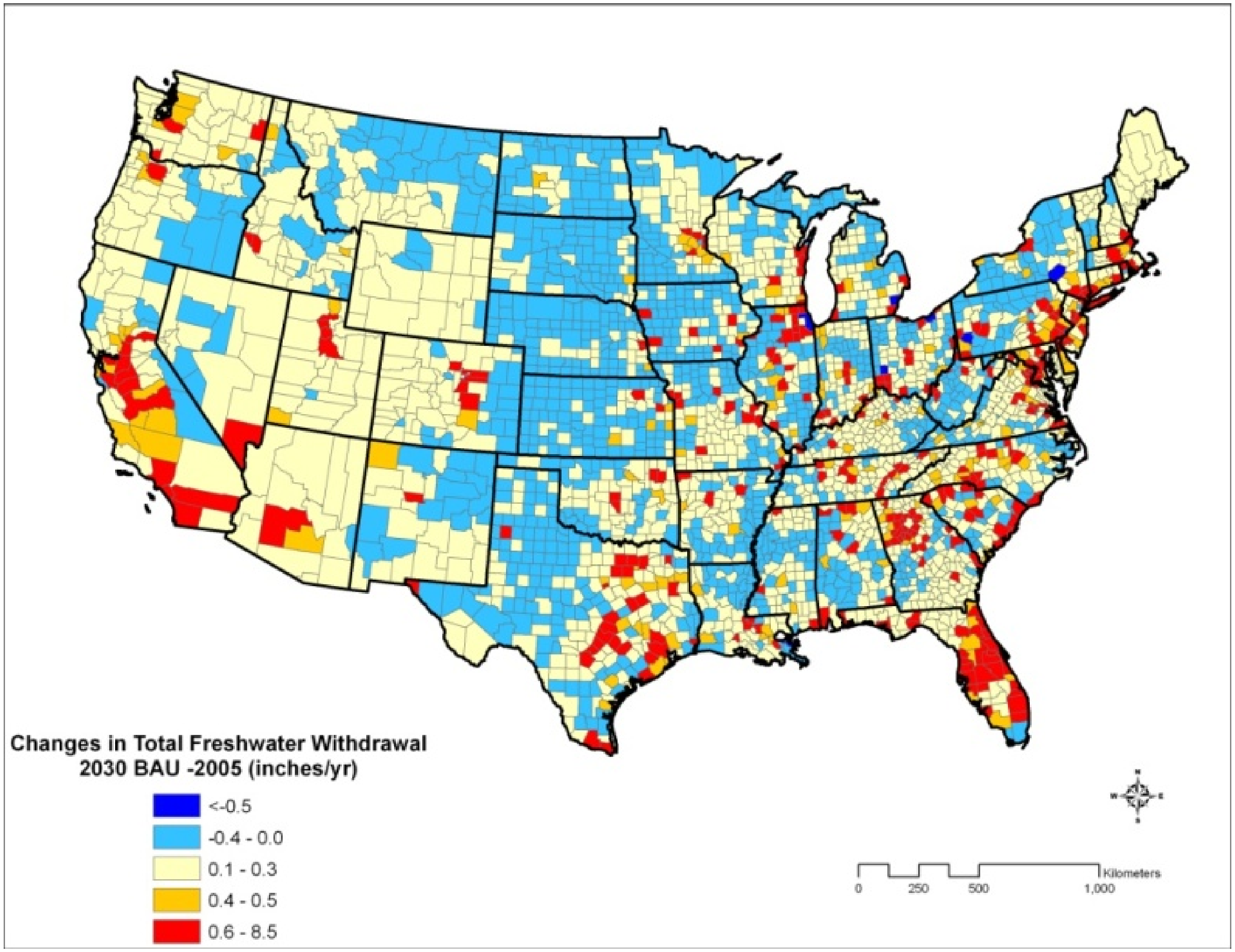
Changes in Freshwater Withdrawals: Business As Usual



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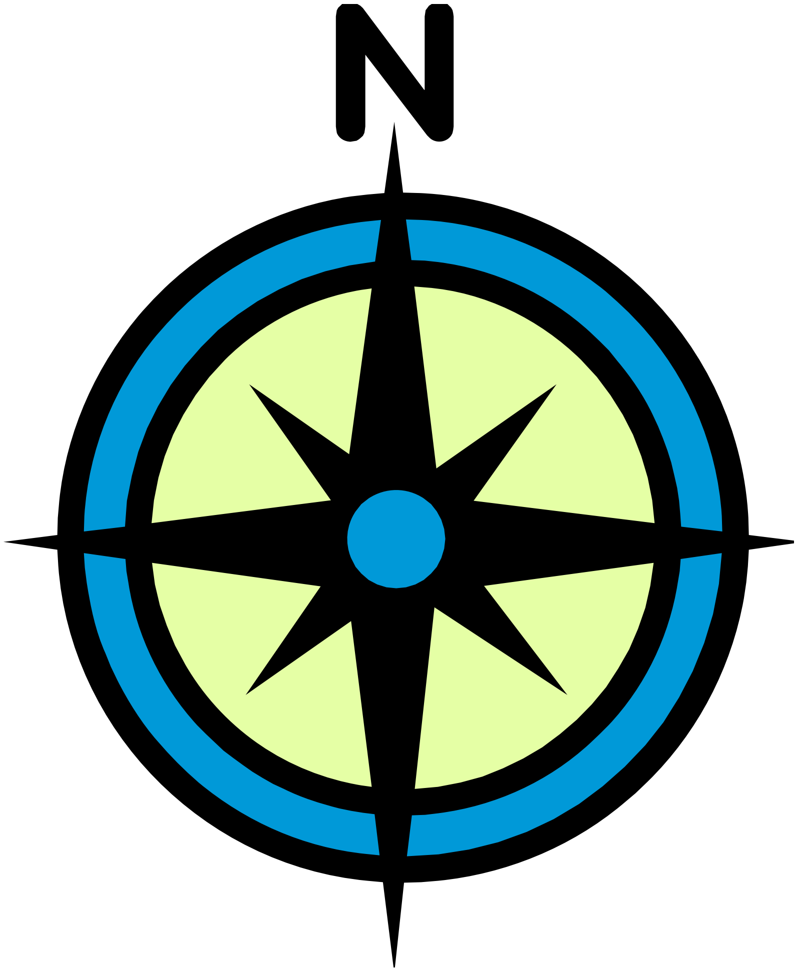
Where from Here?

- Repeat analyses for consumption
- Develop scenarios which include changing agriculture
- Detailed comparison to water availability analyses done by others with alternate methodologies



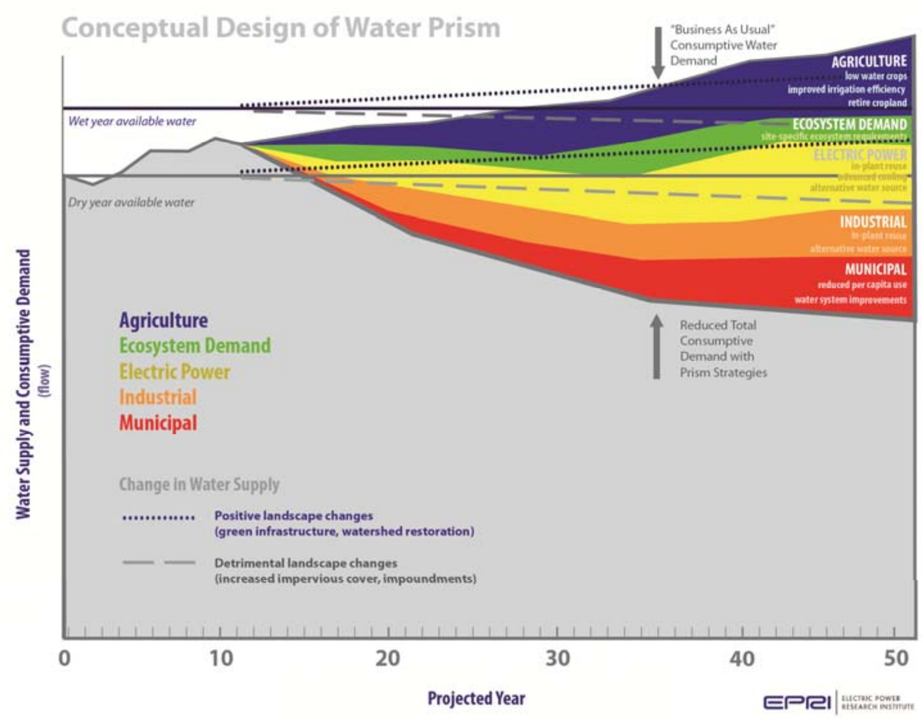
Drivers for Development of Water Prism

- Stakeholders must verify and manage environmental, regulatory, reputational, and financial risks
- Water saving technologies emerging
- A need for tools to implement strategies across all sectors
  - Accommodate future demands within limits of available water
  - Encourage collaborative water planning

Evaluate benefits with a decision support system

Water Prism: Conceptual Design

- Compute system water balance on regional scale
  - Available surface water informed by a watershed model
  - Include groundwater sources and uses



- Project consumptive demand for 40 to 50 year horizon
- Explore water saving strategies through scenario analysis
- Give it the "feel" of EPRI's CO_2 Prism – graphical displays

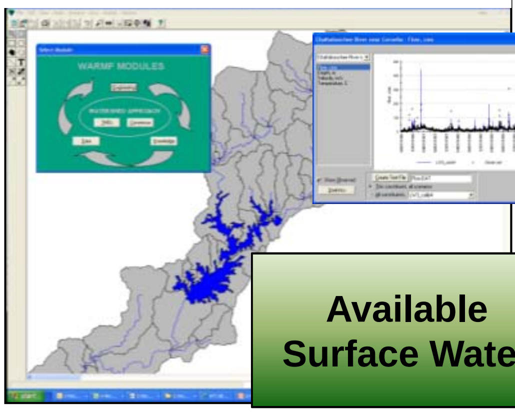
Examine various scenarios to consider water use reductions needed to keep "demand" below "supply"

Water Prism Design Overview

Landuse, Climate, Topography, etc.

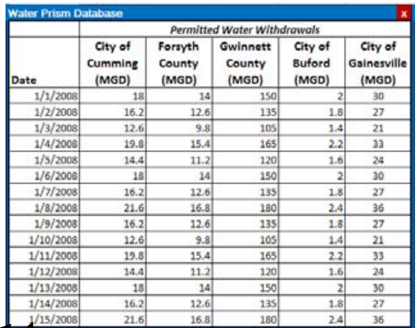
Population, Energy Demand, Irrigated Landuse

Watershed Model



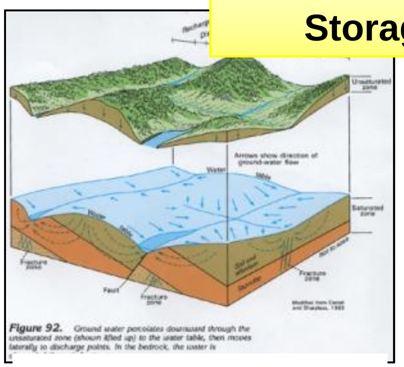
Available Surface Water

Water Prism Access Database


Water Prism Database

	Permitted Water Withdrawals				
Date	City of Cumming (MGD)	Forsyth County (MGD)	Gwinnett County (MGD)	City of Buford (MGD)	City of Gainesville (MGD)
1/1/2008	18	14	150	2	30
1/2/2008	16.2	12.6	135	1.8	27
1/3/2008	12.6	9.8	105	1.4	21
1/4/2008	19.8	15.4	165	2.2	33
1/5/2008	14.4	11.2	120	1.6	24
1/6/2008	18	14	150	2	30
1/7/2008	16.2	12.6	135	1.8	27
1/8/2008	21.6	16.8	180	2.4	36
1/9/2008	16.2	12.6	135	1.8	27
1/10/2008	12.6	9.8	105	1.4	21
1/11/2008	19.8	15.4	165	2.2	33
1/12/2008	14.4	11.2	120	1.6	24
1/13/2008	18	14	150	2	30
1/14/2008	16.2	12.6	135	1.8	27
1/15/2008	21.6	16.8	180	2.4	36

Groundwater Storage

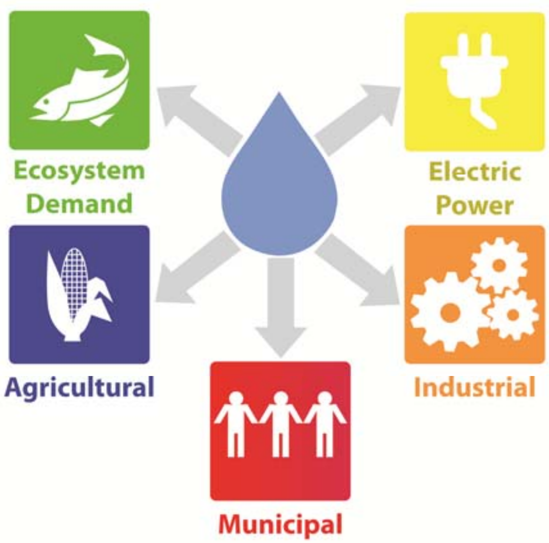


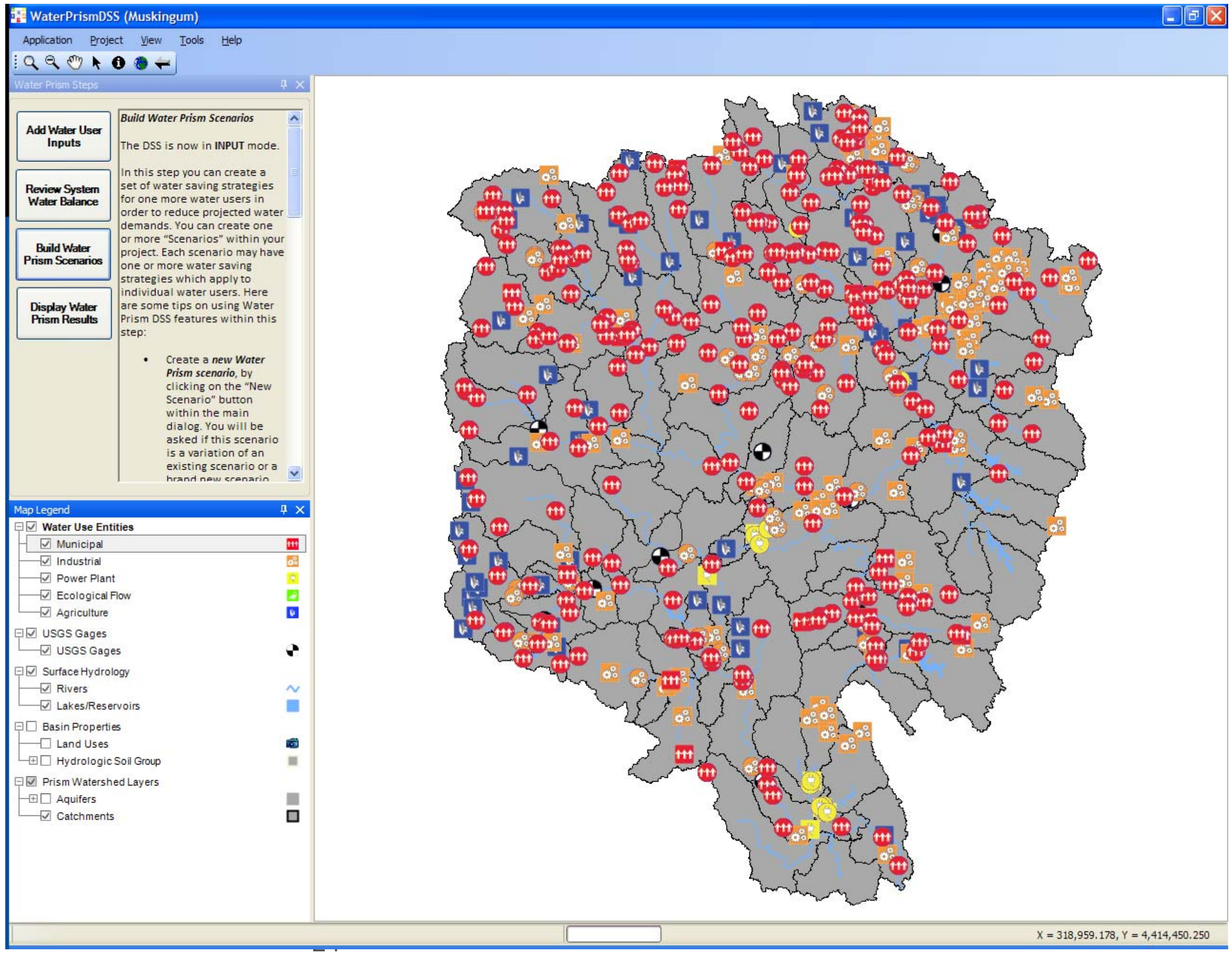
Ground Water Data

Water Prism DSS

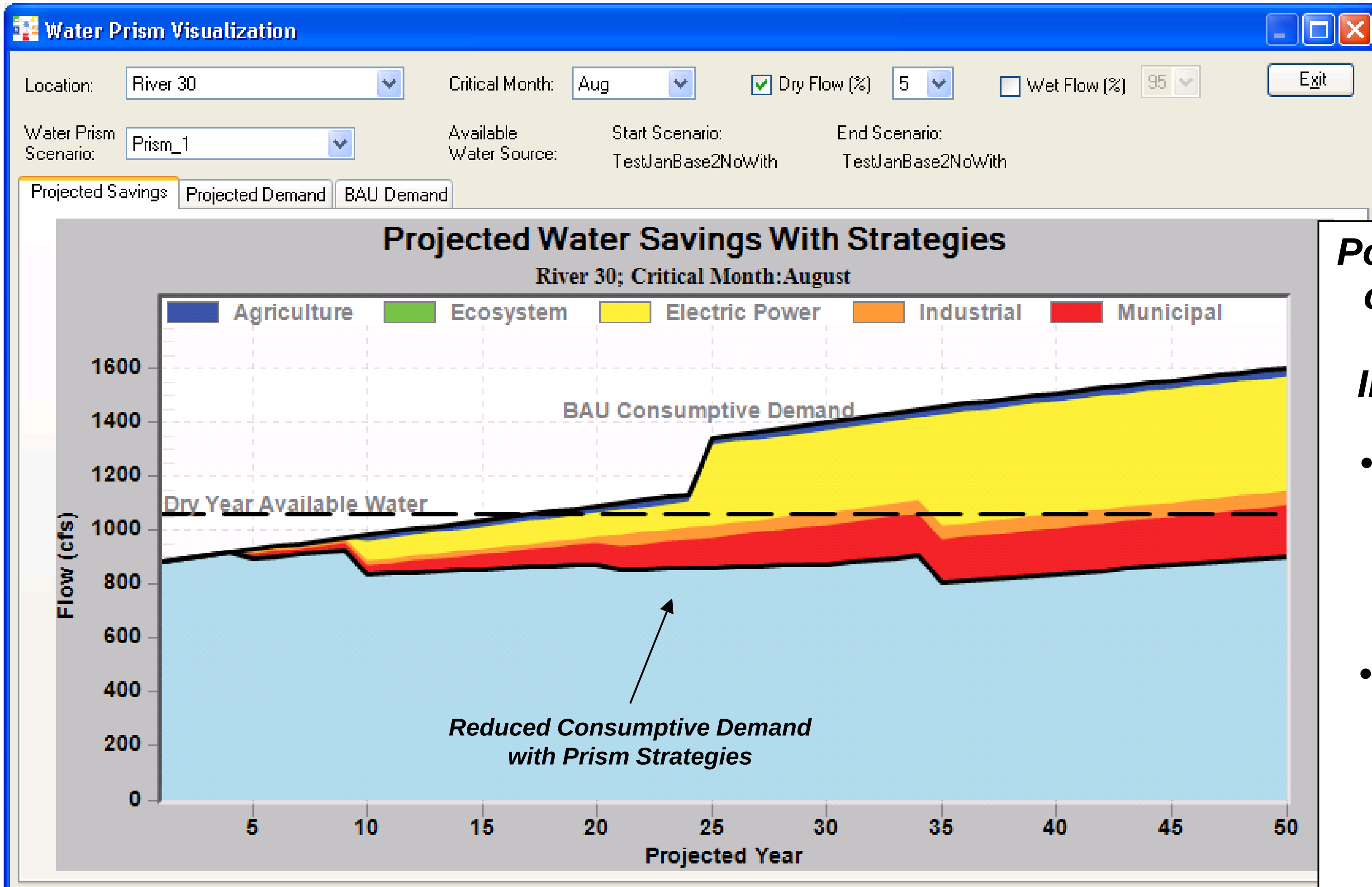
Water Prism Surface Water Module: Entity Inputs

- Squares = Withdrawals (surface and groundwater)
- Circles = Returns





Projected Savings with Prism Strategies



Potential Benefits of Water Prism Strategy Implementation

- **Year 25**: 27 % reduction in consumptive demand
- **Year 50:** 44 % reduction in consumptive demand

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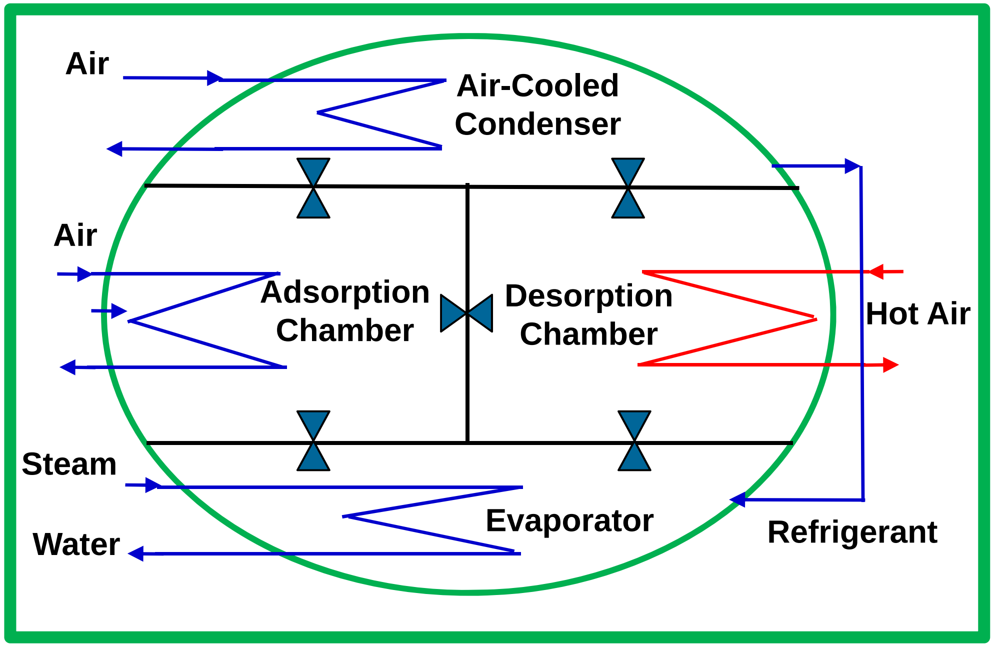
Next Steps

- Add reservoir algorithms
- Finish Green River Basin application
- Publish report in summer 2012
- Enhancements
  - Improve functionality for data development based on external data sources such as projected population or energy demand.
  - Additional output graphics (e.g., water prism strategy timelines, pie graphs, bar charts)
  - Improve data import and computational efficiency
  - Develop “in tool” tips or help system
- Case studies
- Analyze feasibility of water quality and/or economic analyses
- Users manual

Development of Green Adsorption Chiller Enabled Dry Cooling (Collaboration with Allcomp) (EPRI Patent Pending)

Schematic Illustration of a Typical Adsorption Chiller



Key Potential Benefits

- **Near zero** water use and consumption
- Reduced condensation temperature
  - Potential annual increased power production up to 5 %

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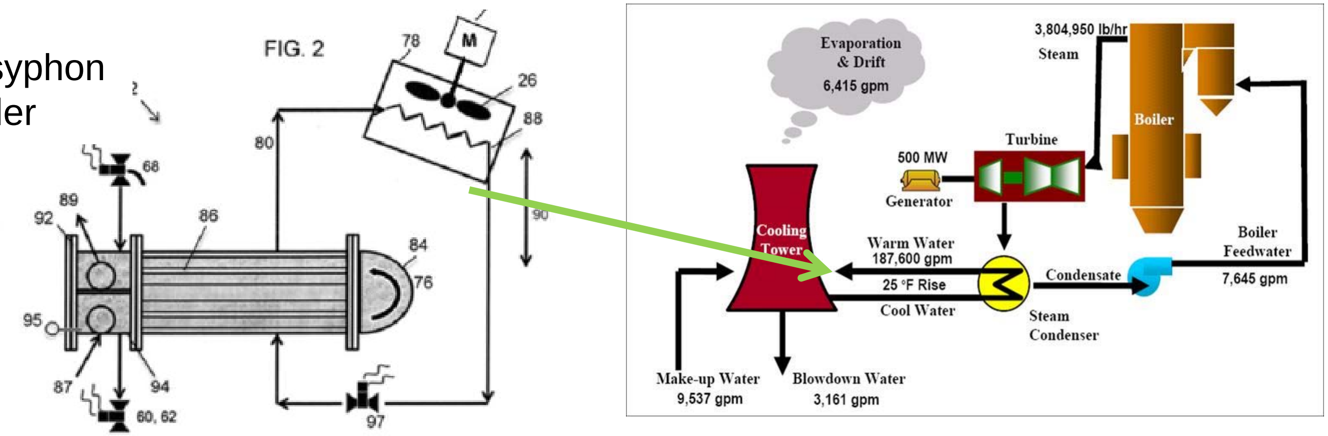
Feasibility Study of Using Thermosyphon Coolers to Reduce Cooling Tower Water Consumption (Collaboration with Johnson Controls Inc.)

As ambient conditions permit, the thermosyphon cooler pre-cools the condenser water leaving the steam surface condenser reducing the evaporative load on the cooling tower

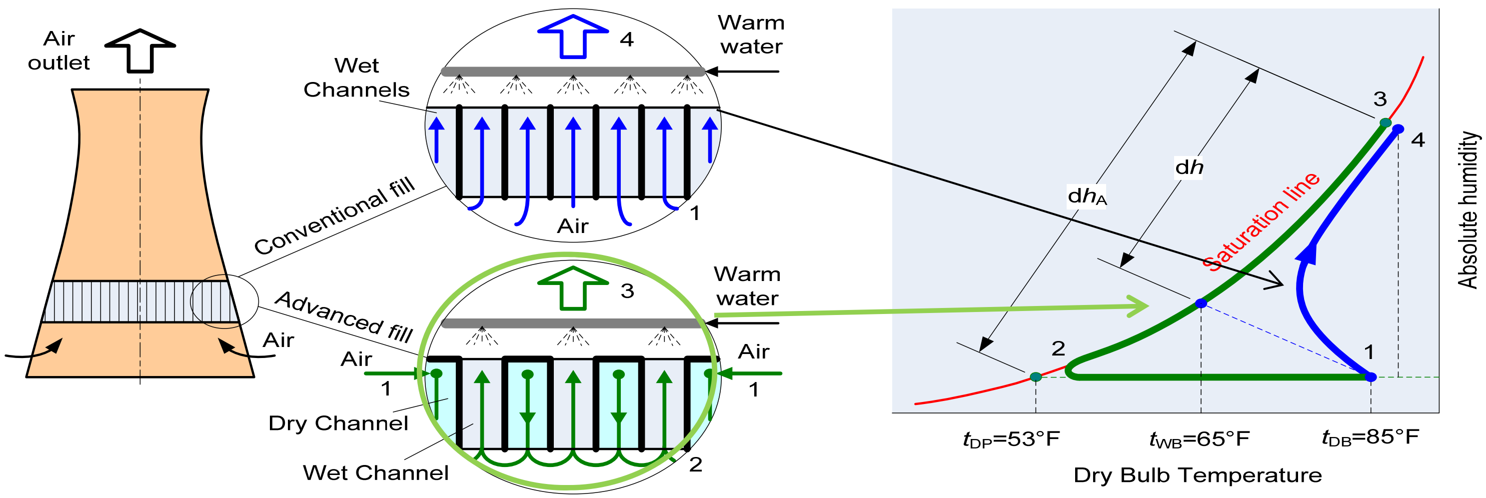
Thermosyphon Cooler



Key Potential Benefits

- Potential annual water savings > 50%
- Compared to ACC, full plant output is available on the hottest days
- Ease of retrofitting
- No increase in surface area exposed to primary steam
- Reduced operating concerns in sub freezing weather
- Broad application (hybrid, new, and existing cooling systems)

Development of Advanced Cooling Tower Fill to Enable Cooling Near Dew Point Temperature Through Maisotsenko Cycle
(Collaboration with Gas Technology Institute) (in contracting)

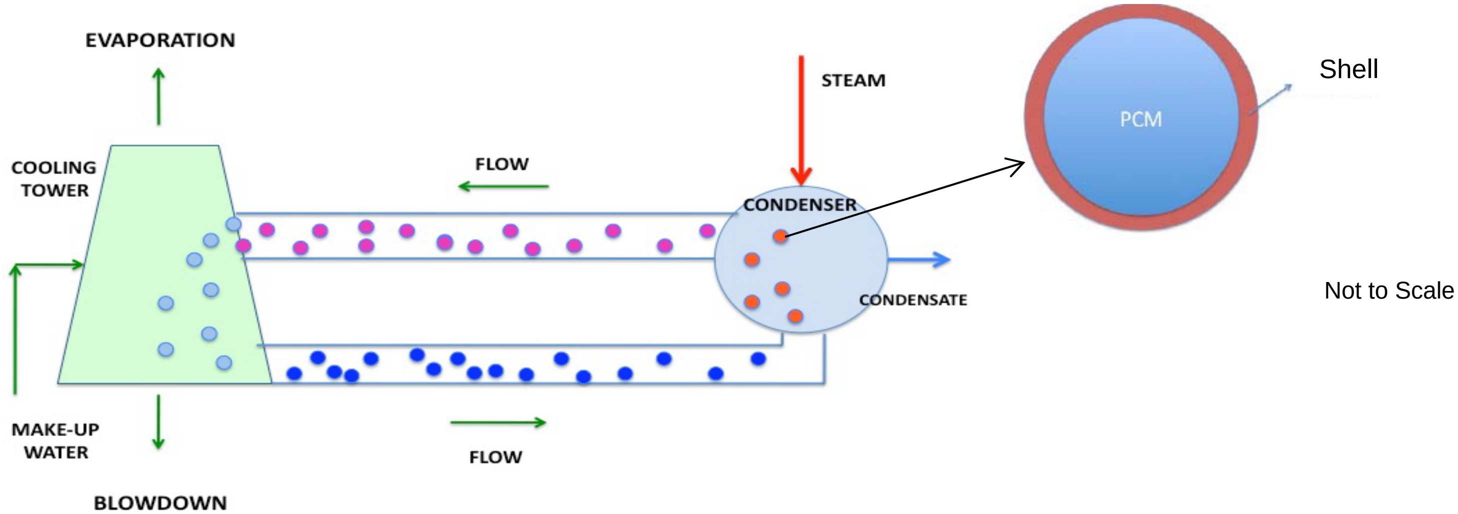


Key Potential Benefits

- Potential for less cooling water consumption by up to 20%
- Lower cooling tower exit water temperature resulting in increased power production
- Ease of retrofitting
- Potential to enhance hybrid cooling

Multi-functional Nanoparticles for Reducing Cooling Tower Evaporative Loss (Collaboration with Argonne National Lab)

Phase Change Material (PCM) Core/Ceramic or Metal Shell Nano-particles added into the coolant.



Key Potential Benefits

- Up to 20% less evaporative loss potential
- Less drift loss
- Enhanced thermo-physical properties of coolant
- Inexpensive materials
- Ease of retrofitting
- Broad application (hybrid/new/existing cooling systems)

Concluding Thoughts

- There is no such thing as Business as Usual - everything is evolving with time
- Everything is distributed non-uniformly in space
- Top down management is necessary for sustainability
- Need localized, fine resolution decision support tool to manage community (watershed, region) water resources
- Research can lead to promising breakthrough technologies to save water