



Energy-Water Nexus in Texas

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<http://www.webberenergygroup.com>

Outline

- **Energy-Water Relationship**
- **Water for Energy**
- **Energy for Water**
- **Future of Energy & Water in Texas**
- **Policy Implications**
- **Questions**



Energy and Water are Interrelated

- We use **water for energy**
 - Cooling during power generation
 - Liquid fuels production



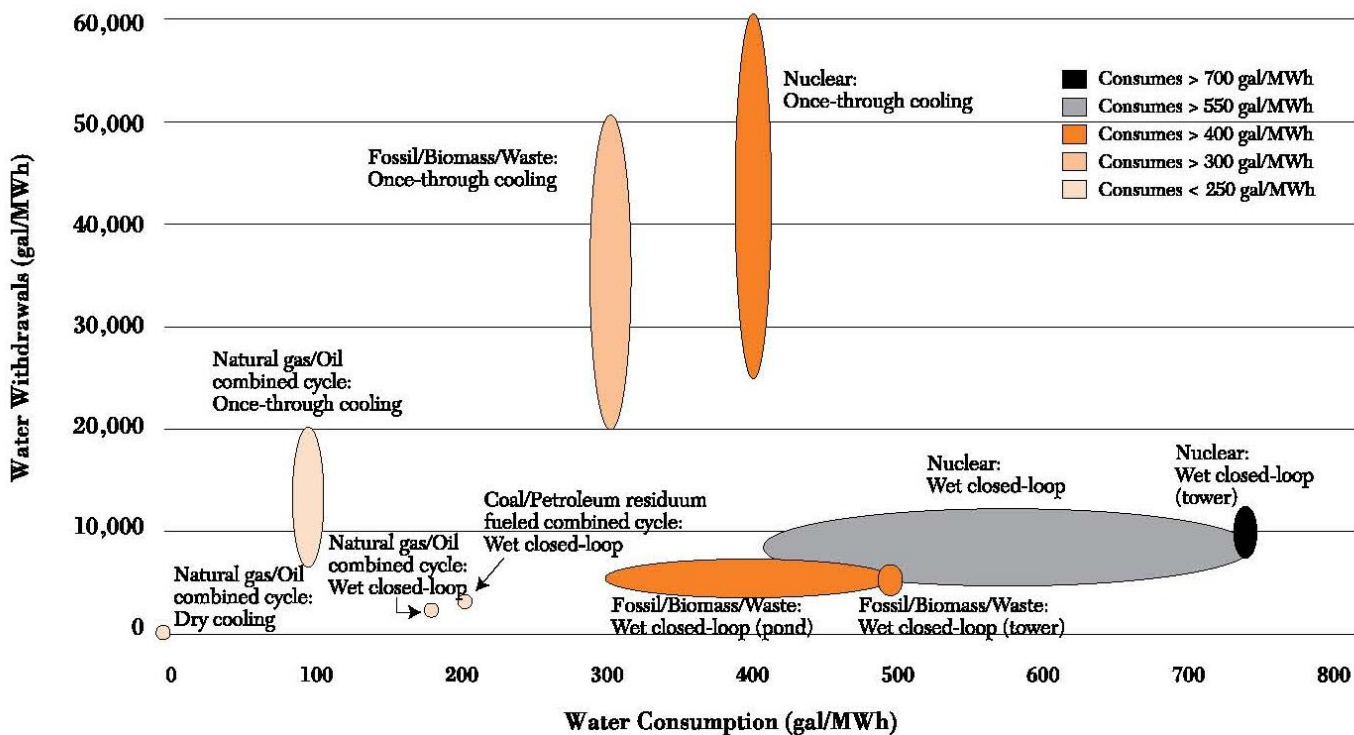
- We use **energy for water**
 - Treatment and disinfection
 - Distribution
 - Heating



Different Fuels Require Different Amounts of Water for Cooling

FIGURE 2

Typical Range of Water Withdrawals and Consumption for Thermoelectric Power Plants



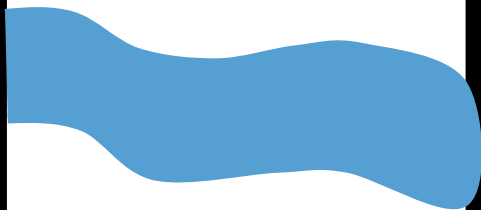
Source: Electric Power Research Institute's "Water & Sustainability (Volume 3): U.S. Water Consumption for Power Production-The Next Half Century."



Water Use for Energy Varies with Cooling Method

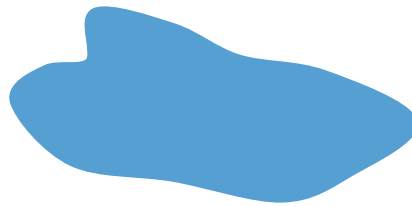
Water for coal power generation

Open-Loop



Withdrawal: 35,000 gal/MWh
Consumption: 300 gal/MWh

Cooling Pond



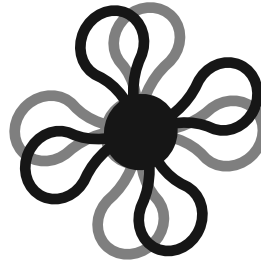
Withdrawal: 450 gal/MWh
Consumption: 385 gal/MWh

Cooling Tower



Withdrawal: 550 gal/MWh
Consumption: 480 gal/MWh

Air-Cooling



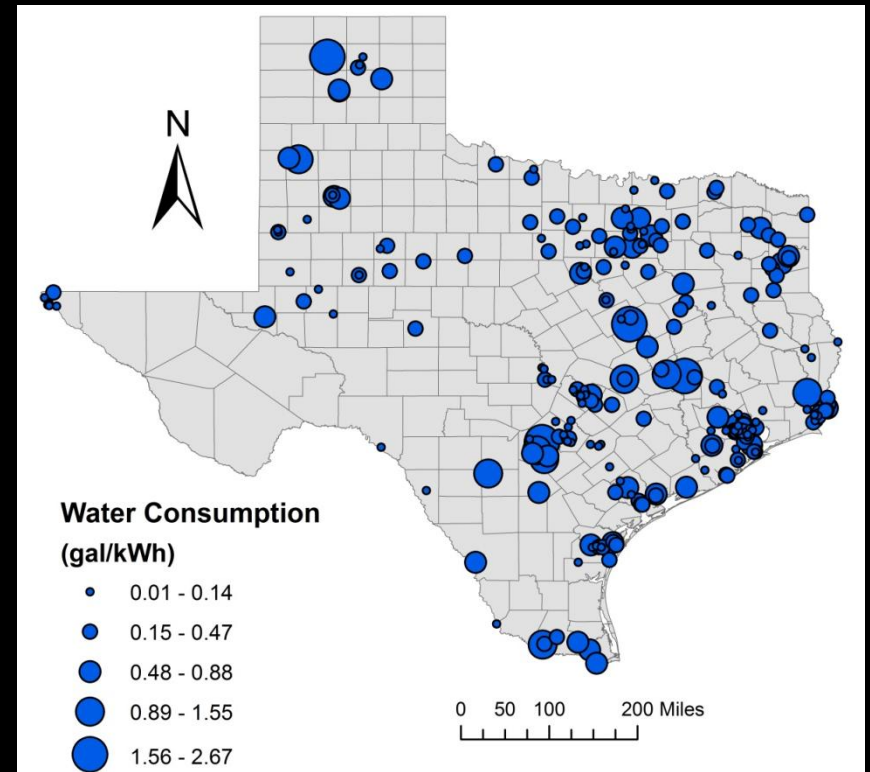
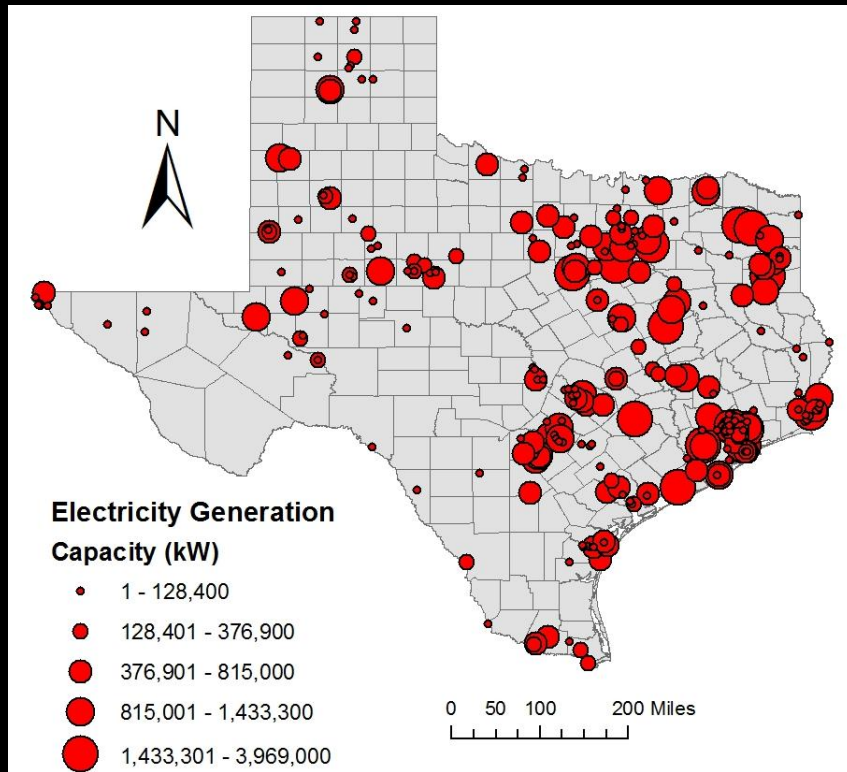
Withdrawal: 0 gal/MWh
Consumption: 0 gal/MWh



Large Power Plants are Large Water Users

Generation Capacity (kW)

Water Consumption (gal/kWh)



Texas consumes **157 billion gallons** of water to produce **400 billion kWh** annually (more than any other state)



Energy Use for Water Treatment Varies with Treatment Type

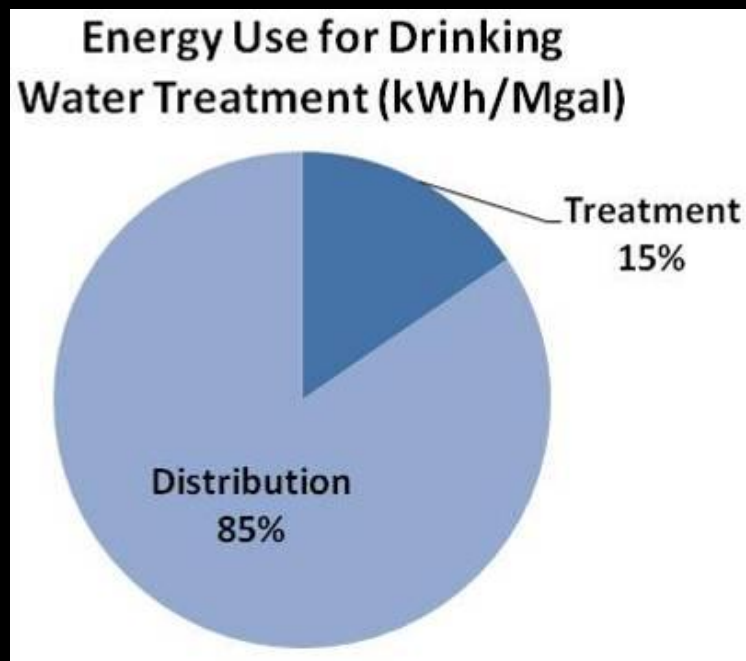
- National average (without distribution)

Water Collection and Treatment	kWh/Mgal
Surface Water Treatment	220
Groundwater Treatment	620
Brackish Groundwater Treatment	3,900-9,700
Seawater Desalination	9,700-16,500

- Often over **half** of a city's total energy consumption goes toward water and wastewater treatment



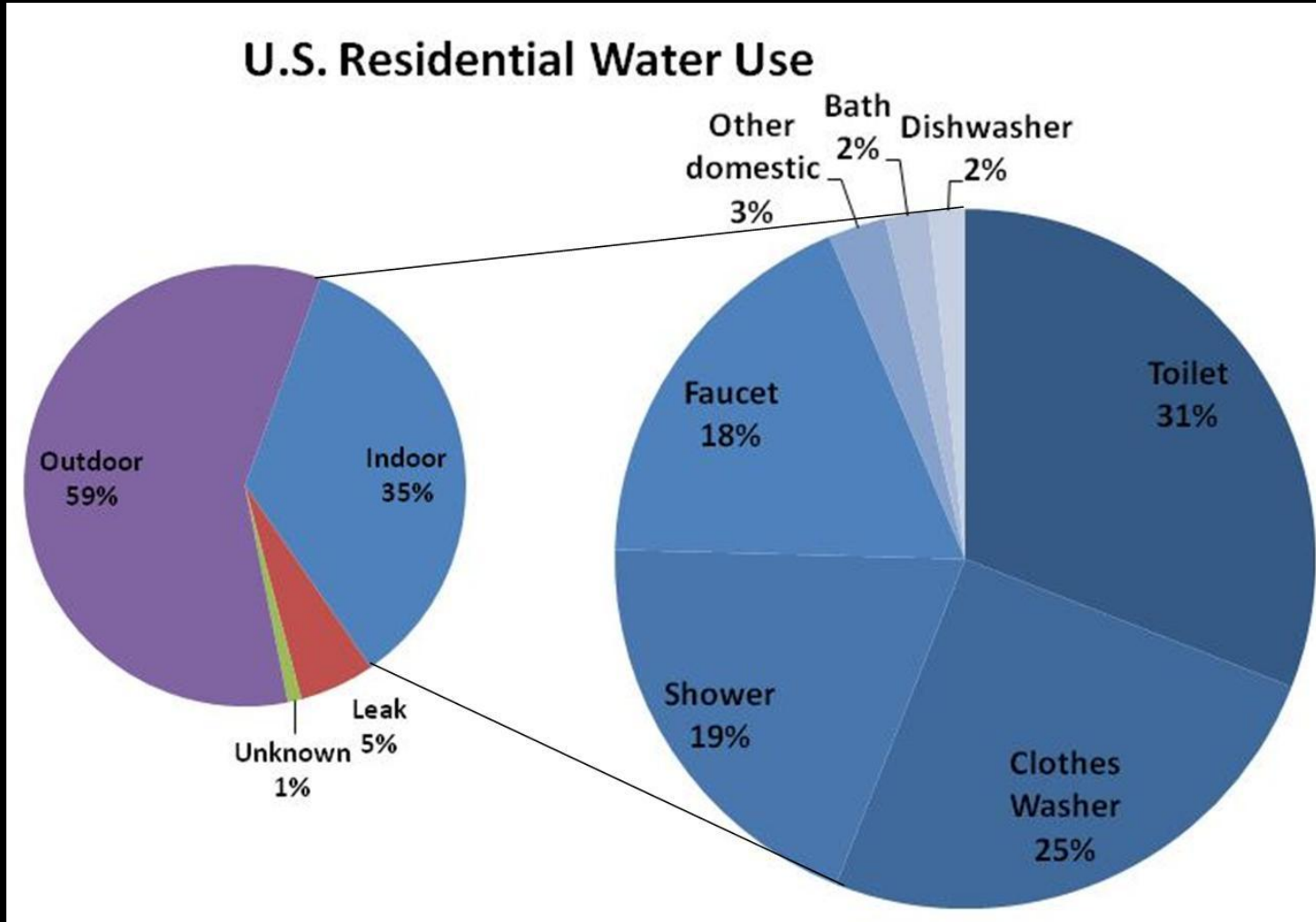
Distribution Constitutes a Large Portion of Energy Use for Water



- Distribution averages **85%** of total energy use
- Less for gravity fed systems
- More for long-haul transfer

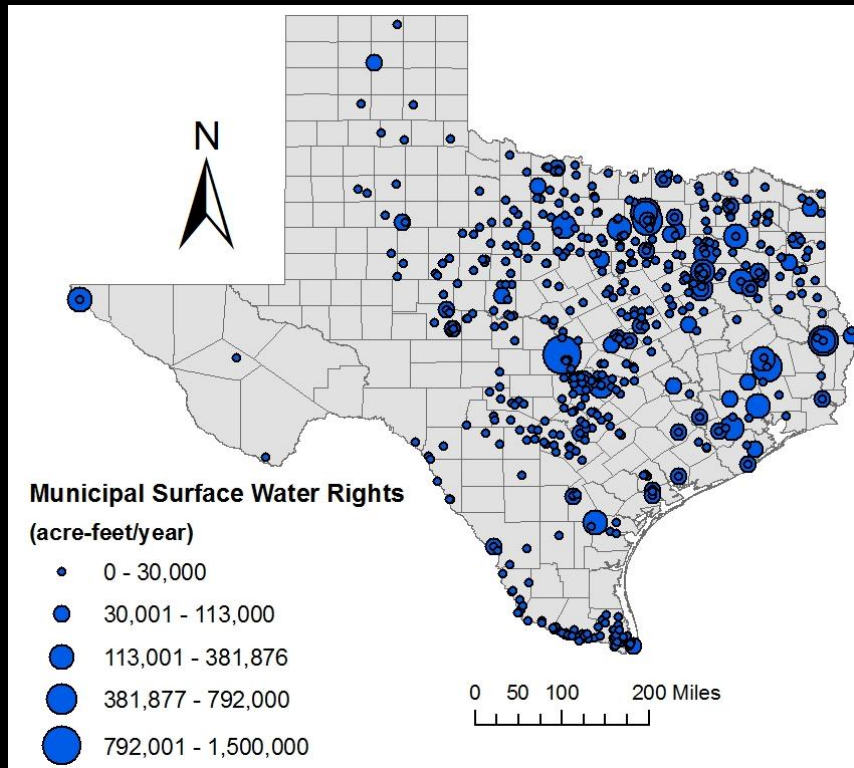


Most of Average American Residential Water Use is Outdoors



Rights to Surface Water in Texas Vary with Geography

Municipal Water Rights (ac-ft/yr)



- Large cities and river authorities hold **large rights**
- Availability for new water rights depends on existing allocations



Energy Use for Wastewater Treatment Varies with Treatment Type

- National average

Wastewater Treatment	kWh/Mgal
Trickling Filter	950
Activated Sludge	1,300
Advanced Treatment without Nitrification	1,500
Advanced Treatment with Nitrification	1,900

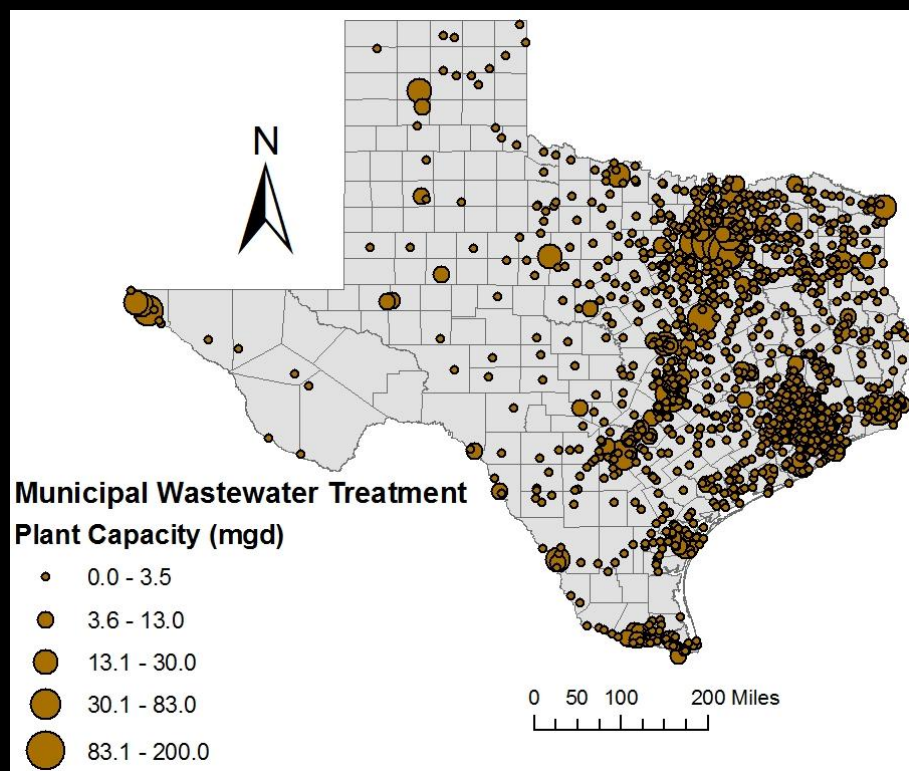
- Wastewater treatment plants show economies of scale with **larger treatment facilities**



Large Wastewater Treatment Plants are Near Large Populations

- Wastewater treatment alone requires **25% more energy** per volume than water treatment and distribution combined
- Unit energy **kWh/Mgal** varies widely with plant size

Wastewater Treatment (MGD)



Texas Does Not Measure Electricity Consumption for Water and Wastewater

- Energy for water and wastewater treatment estimated based on national averages
 - 2.1-2.7 billion kWh to treat 1.5 trillion gallons of water annually
 - 1.8-2.0 billion kWh to treat 1.2 trillion gallons of wastewater annually
- Significant data gap of energy for water



Texas Population is Projected to Increase

- TWDB estimates population to double by 2060 to **46 million people**
- Without conservation or water reuse, more people equals demand for **more energy and more water**
 - Per capita energy use in Texas (**55.4 kWh per person per day**) is highest nationwide (average 40.2 kWh/person/day)
 - Per capita water use in Texas varies from **140-250 gallons per person per day**
- Existing water supplies projected to **exceed demand** after 2012



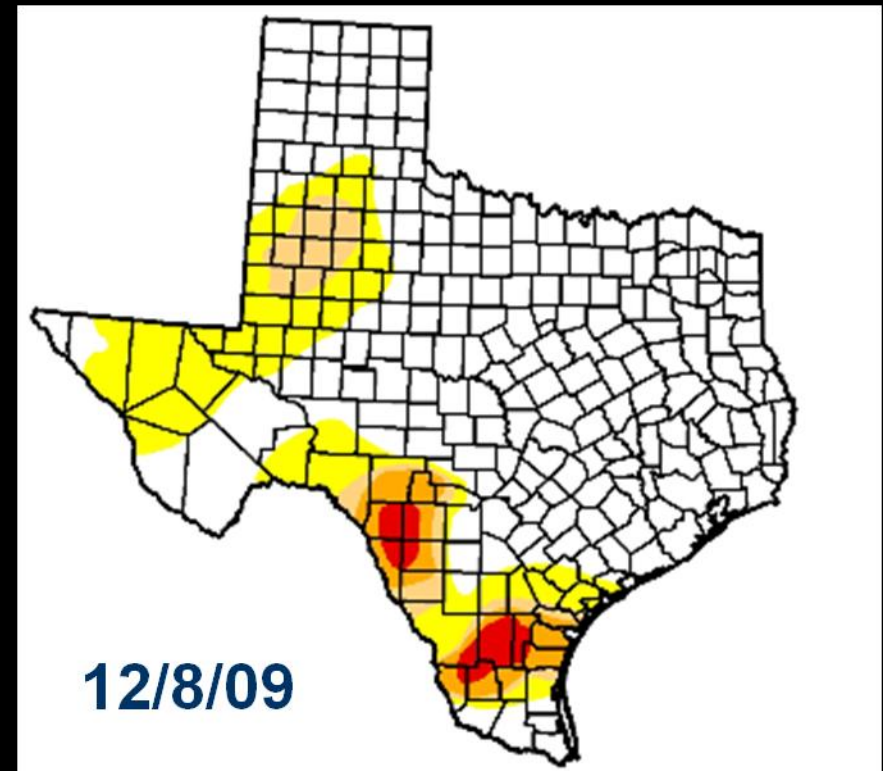
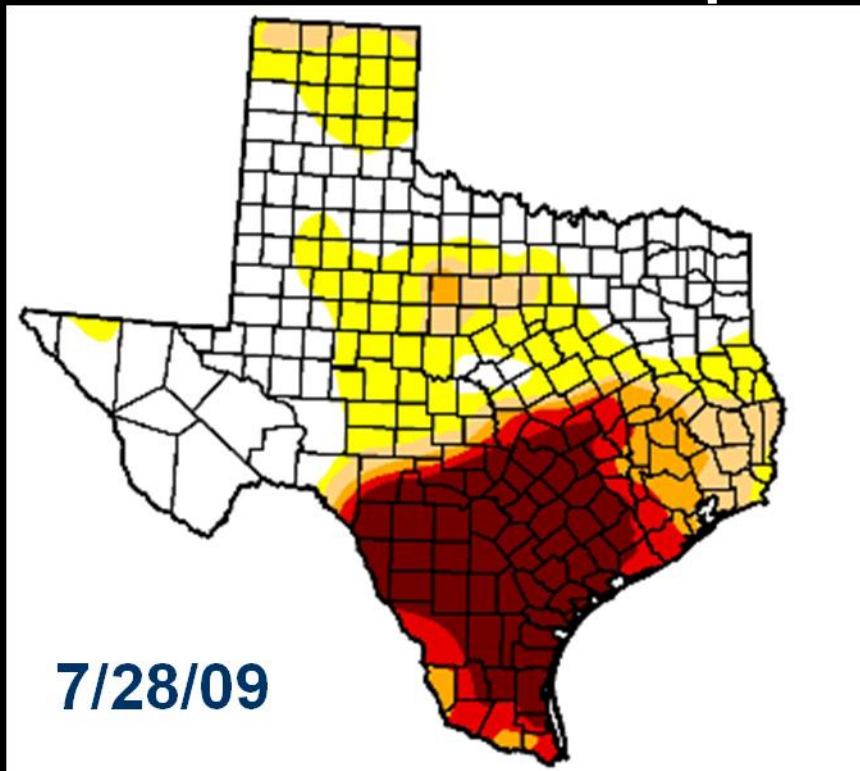
Saving Water Means Saving Energy

- **Conserving water saves energy** needed for treatment and distribution, as well as wastewater treatment
- **Water reuse may also save energy, depending on application**
 - Reclaimed water for irrigation reduces energy for potable treatment
 - Groundwater recharge maintains water levels to save energy from pumping
- **Conserving energy saves water** needed for cooling during electricity generation



Drought Conditions can Prompt Water Conservation

- Drought contingency



– Many violation citations



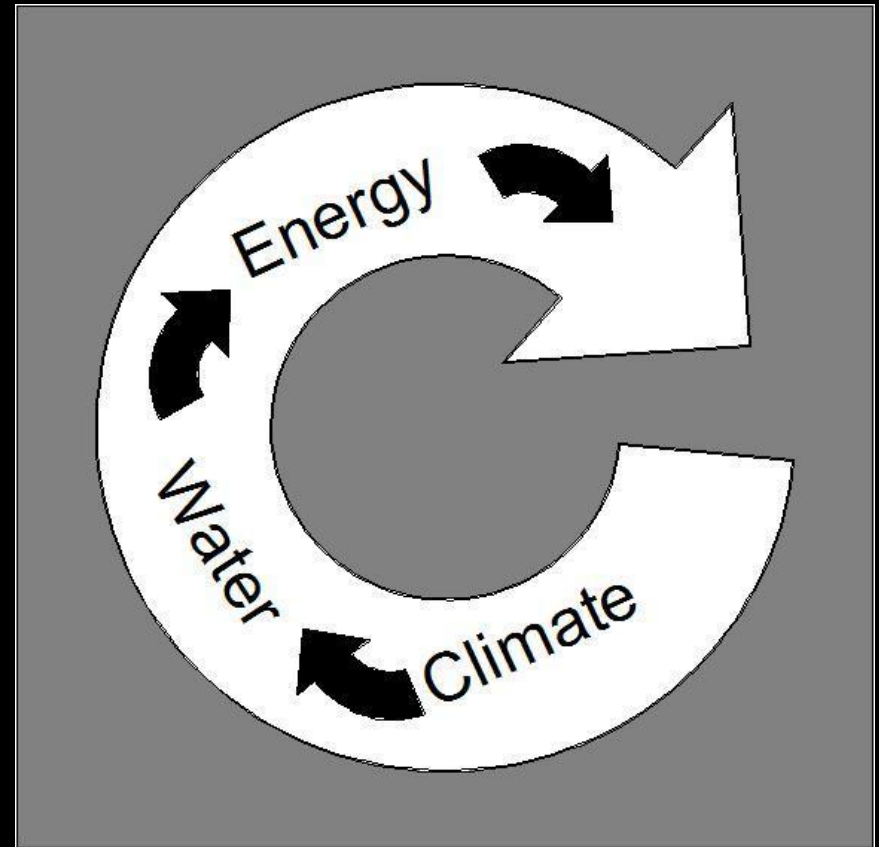
Energy and Water Policy Decisions Affect One Another

- **Air-cooling** of power plants
 - Reduces water consumption
 - Reduces power plant efficiency
- **Stricter standards** for water and wastewater treatment
 - Reduces risk to human health
 - Increases energy use
- **Distant water supplies or desalination**
 - Reliable water source
 - Large distribution or treatment cost and energy use



Tradeoffs Exist between Energy, Water, and Carbon

- Greenhouse gas emissions contribute to **climate change**
- Changing climate alters the **hydrological cycle**
- Inadequate water quality or quantity leads to more **energy-intensive water** supplies



Case Studies are Aimed at Illustrating Effects of Policy Decisions

- **Long distance transfer of desalinated seawater for inland populations**
- **Changing power plant cooling technologies to mitigate water management challenges**
- **Implementing statewide water conservation and reuse practices**
- **Recovering energy from wastewater treatment operations**
- **Harnessing wind power for brackish groundwater desalination**



Acknowledgements

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- Texas Water Development Board
- Environmental Defense Fund
- Energy Foundation
- National Science Foundation
- Environmental Protection Agency



Recent Energy-Water Publications

- **Journal Papers**
 - K. M. Twomey, A. S. Stillwell and M. E. Webber, “Nitrate Contamination as a Result of Biofuels Production and Its Unintended Energy Impacts for Treating Drinking Water,” *Journal of Environmental Monitoring (in press)*.
- **Reports**
 - A. S. Stillwell, C. W. King, M. E. Webber, I. J. Duncan, and A. Hardberger. University of Texas at Austin and Environmental Defense Fund. *Energy-Water Nexus in Texas*. Austin, TX. April 2009. Available: http://www.edf.org/documents/9479_Energy-WaterNexusinTexasApr2009.pdf.
- **Op-Eds, Commentary, and Popular Articles**
 - A. S. Stillwell. “Water Conservation Today and Every Day.” *The Baines Report*, Available: <http://www.lbjjournal.com/baines/?p=725>.
 - C. W. King, A. S. Holman, and M. E. Webber. “Thirst for energy.” *Nature Geoscience*, vol. 1, no. 5 (May 2008), pp. 283-286.
- **Conference Presentations**
 - A. S. Stillwell, C. W. King, and M. E. Webber. “Desalination and Long-Haul Water Transfer: A Case Study of the Energy-Water Nexus in Texas.” *ASME Energy Sustainability Conference*. July 20-3, 2009; San Francisco, CA.
 - A. S. Stillwell and M. E. Webber. “Energy and Water: Integration for Sustainable Policy.” *International Sustainability Conference*. April 23-25, 2009; Villanova, PA.



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