



The Nexus of Energy & Water

Great Lakes Commission

Michael E. Webber, Ph.D.

September 30, 2009

Energy and Water Are the Two Critical Aspects to Modern Civilization

- **More critical than food:**
 - modern food production requires energy & water
- **More critical than healthcare:**
 - top global public health problem: access to clean water & sanitation (e.g. wastewater treatment)
- **More critical than law & order:**
 - Katrina: lawlessness follows blackouts (food spoilage) and lack of water availability



There Are Four Main Points to Remember

- 1. Energy and water are interrelated**
 - we use energy for water and water for energy
- 2. The energy and water relationship is already under strain**
 - constraints in one resource introduce constraints in the other
- 3. Trends imply these strains will be exacerbated**
 - Population growth increases total demand
 - Economic growth increases per capita demand
 - Global climate change intensifies the hydrological cycle
 - Policy shifts towards increasing water-intensity of energy and energy-intensity of water
- 4. There are different policy actions that can help**

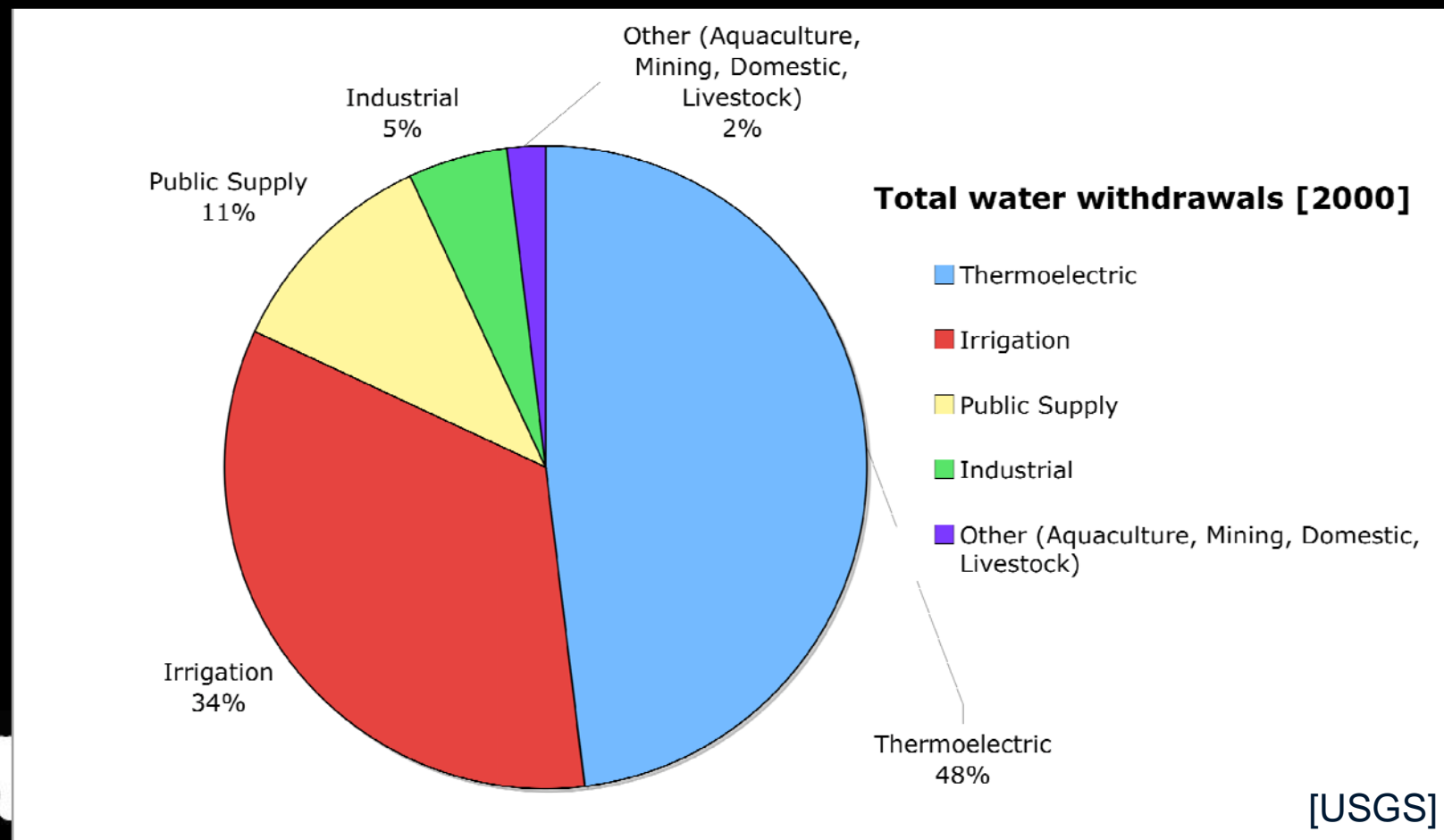


Energy and Water are Interrelated



The Thermoelectric Power Sector is the Largest User of Water in the US

- 48% of total water withdrawals (39% of freshwater withdrawals)
- **Withdrawal:** 1-40 gal/kWh **Consumption:** 0.25-1 gal/kWh

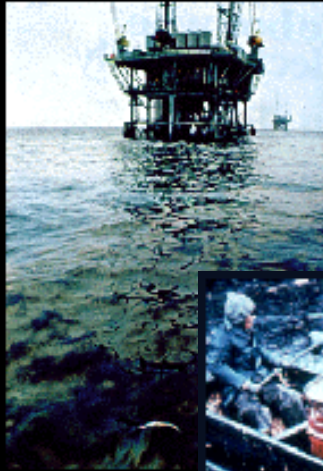


The Water Sector Uses a Lot of Energy

- **Energy is used to produce, move, heat and treat water**
 - ~ 3% of U.S. electricity for water/wastewater plants
 - ~10%+ including end-use (heating, etc.)
- **Largest energy user in most municipalities (~50%)**
 - **most WWTPs are municipally-owned**
- **California is an extreme example**
 - **CA spends ~19% of its electricity on water**
 - **primarily for end-use**
 - **SoCal uses a lot of energy for conveyance**
 - **similar story wherever water is scarce**



Energy Production, Distribution and Use Can Impact Water Quality



**Santa
Barbara
Channel
(1969)**



**Exxon Valdez
(1989)**



Oil Spills Continue to Happen



Korea; Source: AP News

11/11/07:

Oil Spills into the SF Bay

11/12/07:

Oil spills into the Black Sea

12/7/07:

Oil spills onto Korean coast

Underground leaks of MTBE also affect water quality



Coal Spills, Too--It's Not Just Oil Spills

The New York Times

December 24, 2008



J. Miles Cary/Knoxville News Sentinel

- “Coal Ash Spill Revives Issue of Its Hazards”, NYT, 24 Dec 2008
 - The spill released about 300 million gallons of sludge & water
 - Much larger than Exxon Valdez

Coal Ash Spill Revives Issue of Its Hazards

A Tennessee Valley Authority employee surveyed a home on Tuesday.

“...the spill reignited a debate over whether the federal government should regulate coal ash as a *hazardous* material. Similar ponds and mounds of ash exist at hundreds of coal plants around the nation...<snip>...the Edison Electric Institute estimated that the industry would have to spend up to \$5 billion in additional cleanup costs if the substance were declared *hazardous*.”



J. Miles Cary/Knoxville News Sentinel, via Associated Press

Fifteen homes like this one in Harriman, Tenn., were flooded with fly ash sludge on Monday after a storage pond wall broke.

By SHAILA DEWAN

Published: December 24, 2008



The Energy-Water Relationship Is Already Under Strain



Michael E. Webber, Ph.D.
Energy & Water 10
September 30, 2009

The Energy-Water Relationship Is Already Under Strain

- **Record heat wave in France in 2003**
 - nuclear power plants dialed back because of inlet water temperatures (less cooling capability) and rejection water temperature limits
- **“Droughts could close nuclear power plants: Southeast water shortage a factor in huge cooling requirements”**
 - *Associated Press*, January 23, 2008
- **Civil War Between Georgia and Tennessee?**
 - “Georgians want access to Tennessee water”
 - *The Tennessean*, February 8, 2008
 - move the border 1 mile north to give GA access to the Nickajack Reservoir on the dammed Tennessee river



Trends Imply That Strain in the Energy-Water Relationship Will Be Exacerbated



Michael E. Webber, Ph.D.
Energy & Water 12
September 30, 2009

Trends Imply That Strain in the Energy-Water Relationship Will Be Exacerbated

- **Population growth**
 - drives up total demand for energy & water
- **Economic growth**
 - drives up per capita demand for energy & water
 - might be counteracted by efficiency
- **Climate change**
- **Policy choices**
 - movement towards energy-intensive water and water-intensive energy

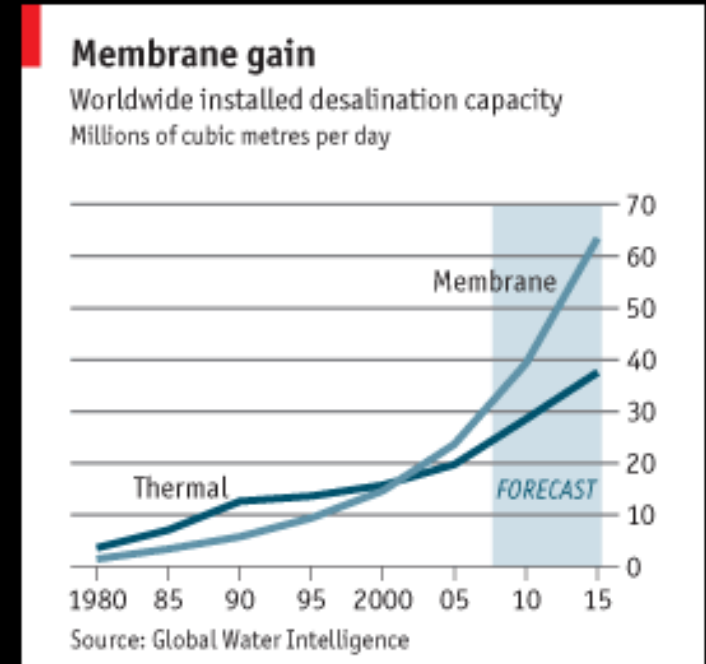


***Trends Imply Energy Intensity of Water and
Water Intensity of Energy Are Likely to Grow
Because of Policy Choices***



We Are Moving Towards More Energy-Intensive Water

- **Stricter water/wastewater treatment standards**
- **Deep aquifer production**
- **Desalination**
 - **Worldwide capacity to double by 2025**
 - **Middle East, London, San Diego, TX**
- **Long-haul pipelines and inter-basin transfer**
 - **China, India, Texas**
- **Desalination plus long-haul transfer**

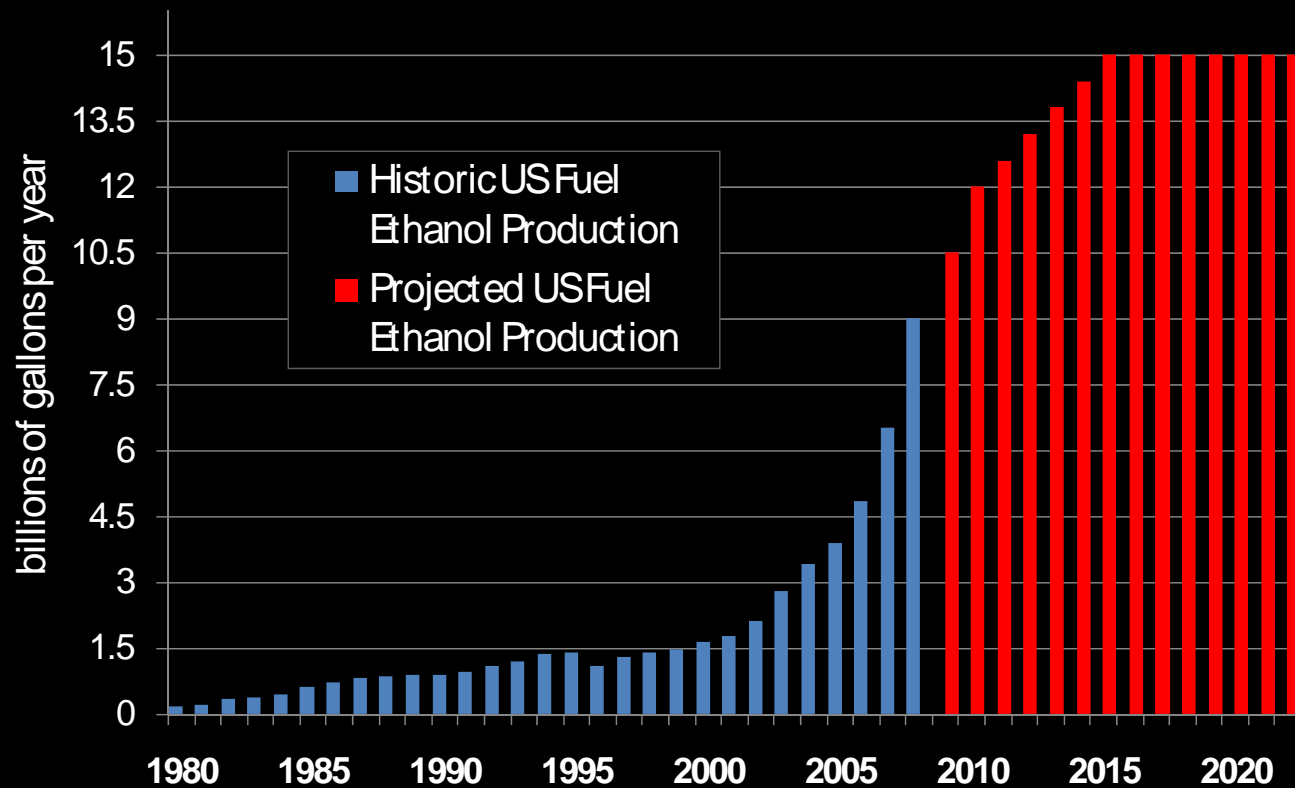


Economist, June 7, 2008



EISA 2007 will significantly increase the production of biofuels in the future

Annual US Fuel Ethanol Production¹²



¹Renewable Fuels Association, *Historic U.S. Fuel Ethanol Production*,

²Renewable Fuels Association, *RFS Schedule under the Energy Independence and Security Act of 2007*



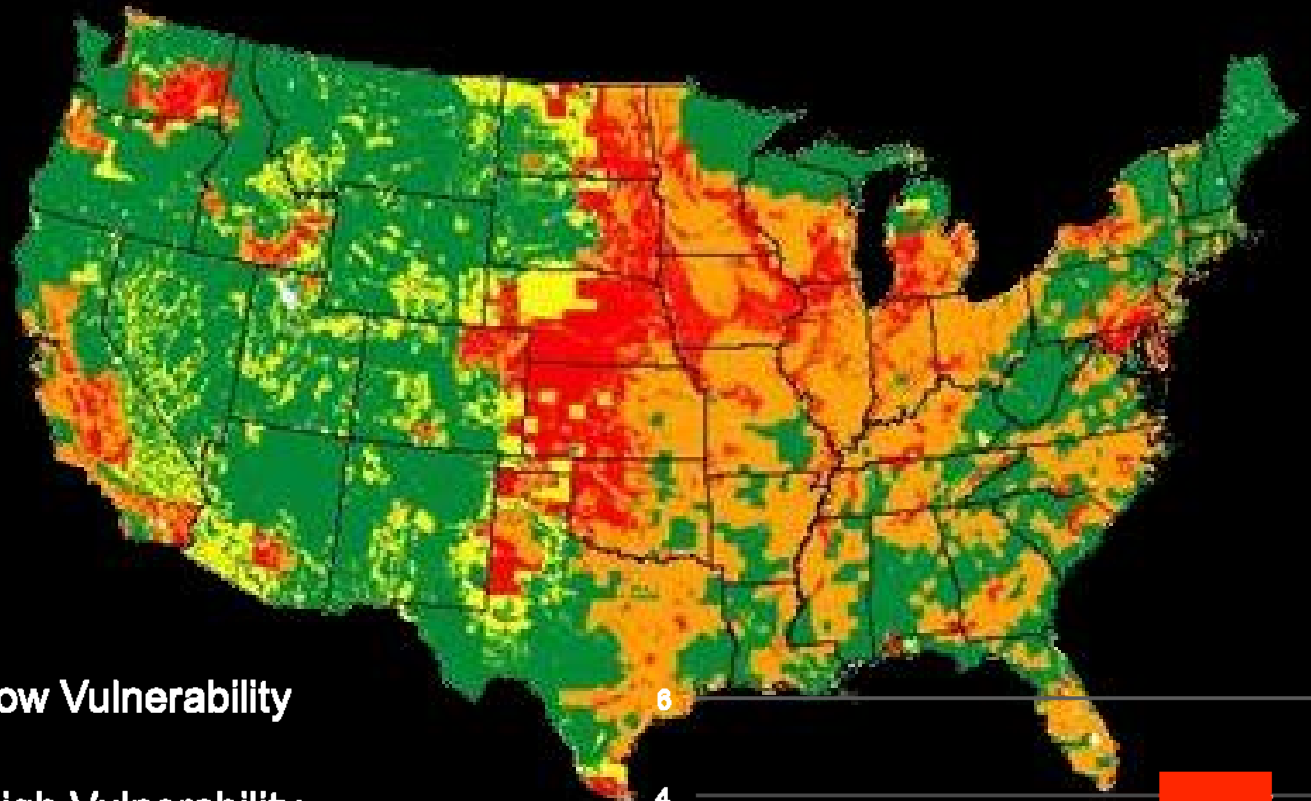
Corn starch based ethanol production has well-cited water quality implications...

- ↑ Corn production**
- ↑ Fertilizer use**
- ↑ Runoff/nutrient loading to downstream water bodies**
- ↑ Increased nitrate contamination in water sources**
- ↑ Increased energy for water treatment**

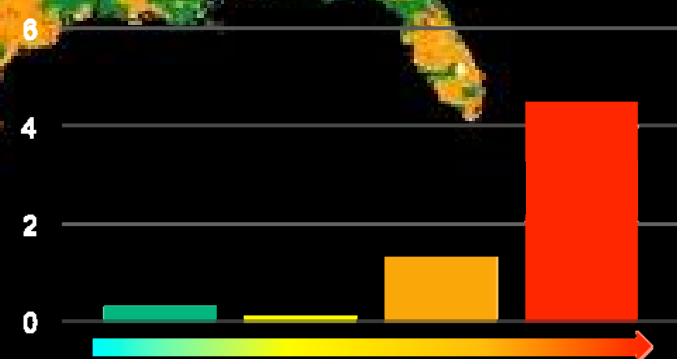


The majority of high risk groundwater wells are concentrated in the Corn Belt

[Twomey, 2009]



- Low Input, Low Vulnerability
- Low Input, High Vulnerability
- High Input, Low Vulnerability
- High Input, High Vulnerability



(Adapted from : Nolan B. Relating Nitrogen Sources and Aquifer Susceptibility to Nitrate in Shallow Ground Waters of the United States. Ground Water 2001;39:290.)

Michael E. Webber, Ph.D.
Energy & Water 18
September 30, 2009

We Are Moving Towards More Water-Intensive Energy

- **Nuclear power, Solar CSP**
 - **Note:** also choosing water-lean energy forms
 - Solar PV, wind, natural gas
- **Future transportation fuels are especially thirsty**
 - **Electricity (2-3x worse)**
 - **Unconventional fossil fuels (2-4x worse)**
 - **Hydrogen (1-500x worse)**
 - **Biofuels (1-1000x worse)**



There Are Policy Opportunities At The Energy- Water Nexus



Michael E. Webber, Ph.D.
Energy & Water 20
September 30, 2009

Water Conservation and Energy Conservation Are Synonymous

- **Policies that promote water conservation also achieve energy conservation**
- **Policies that promote energy conservation also achieve water conservation**



Energy/Water Policy Recommendations

- **Collect, maintain and make available accurate, updated and comprehensive water data**
- **Conduct integrated policymaking**
- **Establish oversight of water *quantity***
 - **EPA is in charge of water *quality***
- **Establish strict federal standards in building codes for water efficiency**
 - **purple piping, rain barrels, low-flow appliances**



Energy/Water Policy Recommendations cont'd

- **Invest heavily in water-related R&D to match increases in energy-related R&D**
 - **low-energy water treatment, desalination, etc**
- **Work closely with USDA to develop and implement drip irrigation systems**
- **Focus on biofuels feedstocks that do not require freshwater irrigation (e.g. algae)**
- **Match water permitting with air permitting for power plants**



Energy/Water Policy Recommendations cont'd

- **Fund dry cooling systems at powerplants**
- **Support reclaimed water use at powerplants, industry and agriculture**
- **Rethink water markets**
 - **Water is widely expected to be free and unlimited...**

...those days are over



Michael E. Webber, Ph.D.

Associate Director

**Center for International Energy & Environmental Policy
Jackson School of Geosciences**

Assistant Professor

**Thermal Fluids Area, Mechanical Engineering
Cockrell School of Engineering**

Co-Director

**Clean Energy Incubator
Austin Technology Incubator**

webber@mail.utexas.edu

Webber Energy Group



<http://www.webberenergygroup.com>