

REINHOLD ENVIRONMENTAL Ltd.



**2014 Wastewater-Ash Round Table
& Expo Presentation**

September 22, 2014, in Birmingham, AL / Hosted by Southern Company

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“Water-Energy Nexus”

Mark S. Berry, PhD, PE

September 22nd, 2014

2014 Waste Water-Ash Round Table and Expo

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Link between Population, Energy, & Water

WATER ENERGY-NEXUS

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“Useful Definitions”

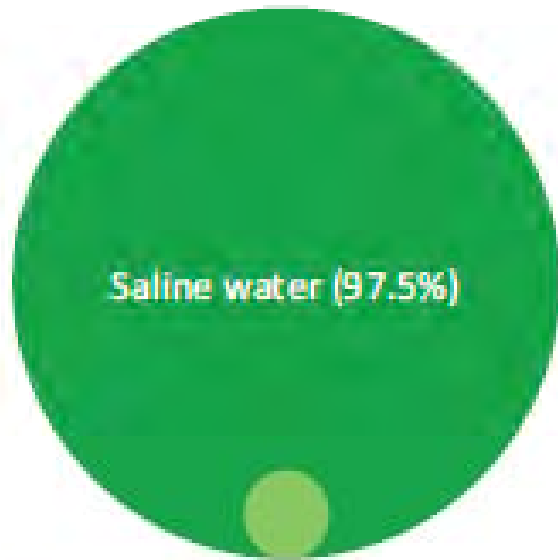
- Water Withdrawal - is the total amount of water taken from a lake, river, or aquifer for any purpose.
- Water Consumption – fraction of withdrawn water that is lost in transmission, evaporation, absorption, chemical transformation, or otherwise made unavailable for other purposes as a result of human use.
- Water Quality - It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose.
- Water-Energy Nexus – the connection between the need for water to produce energy and the need for energy to produce clean water.



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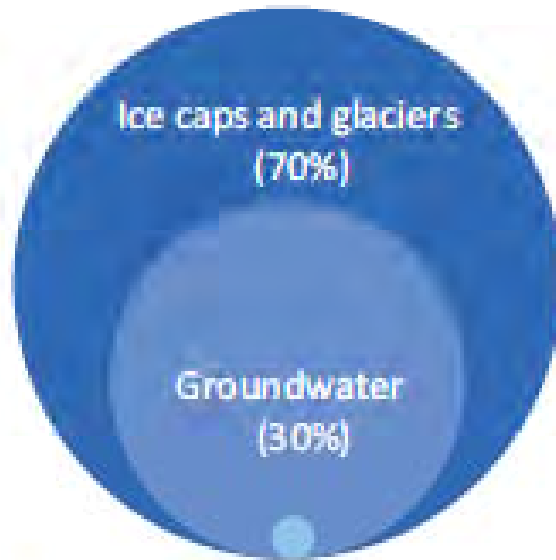
“Where Does Water Come From?”

Total water resources



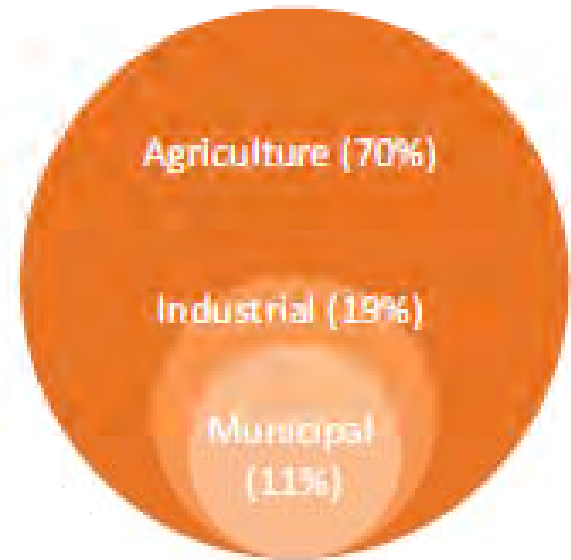
Freshwater (2.5%)

Freshwater resources

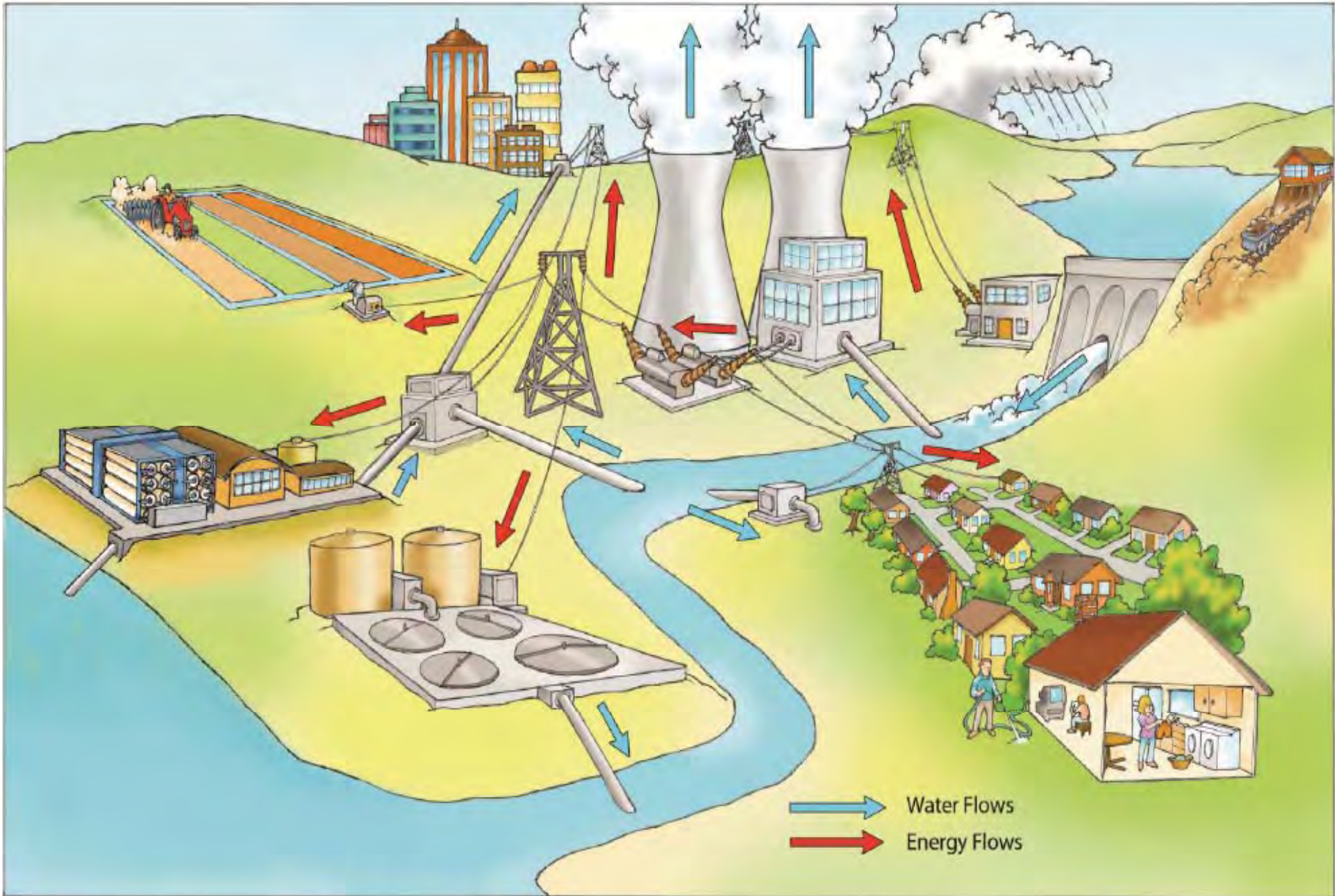


Surface water (0.3%)

Human freshwater use



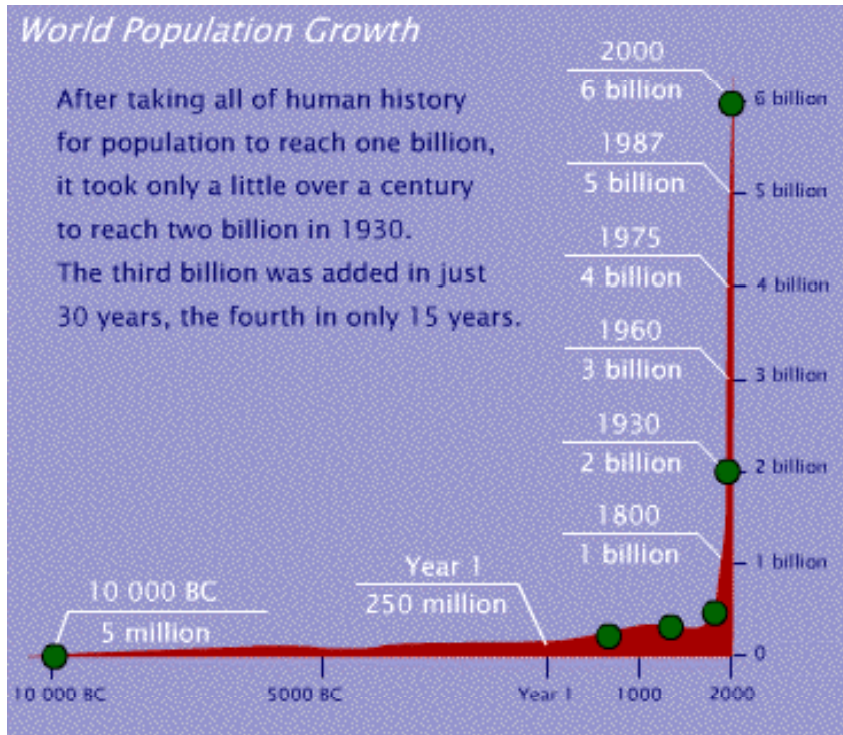
Sources: Shiklomanov (1993); UN FAO Aquastat database.



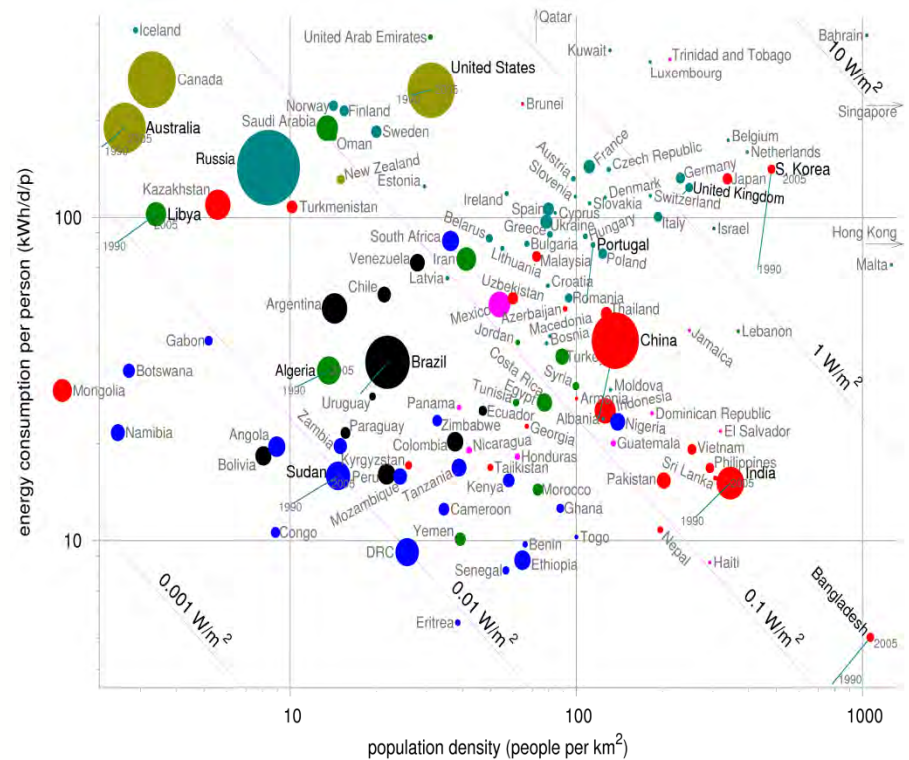
Source: Goldstein, R. "The Energy-Water Nexus: Water Resource Sustainability and the Role of the Electric Power Sector" EPRI Washington Seminar Series. May 20th, 2014.

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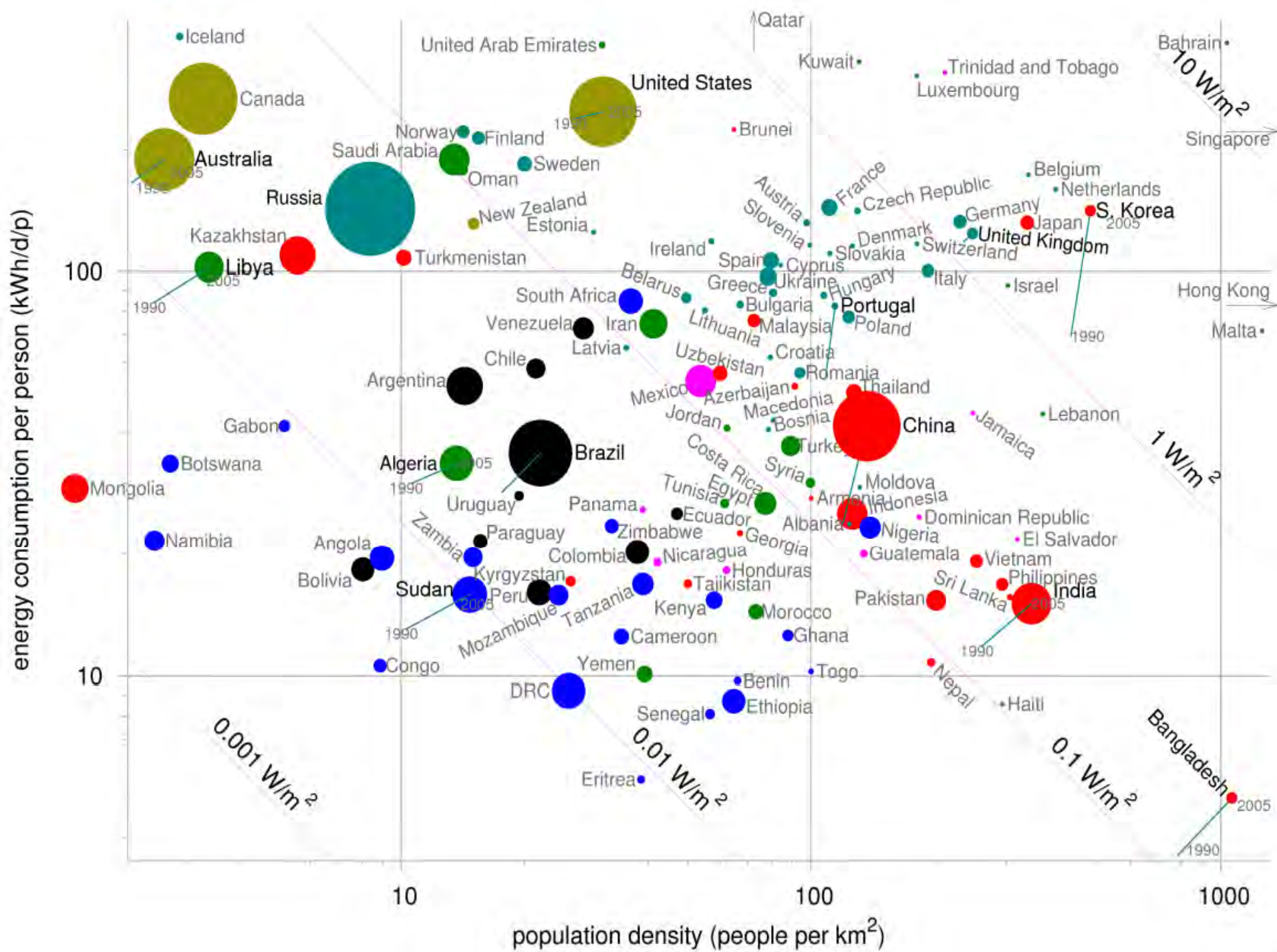
“Energy & Population”



Source: Population Expo



Source: David MacKay - How the Laws of Physics Constrain Our Sustainable Energy Options Ted Talk: Mar 22, 2012



“Thoughts”

Energy

Electricity

Industrial

Water Quality

Rural

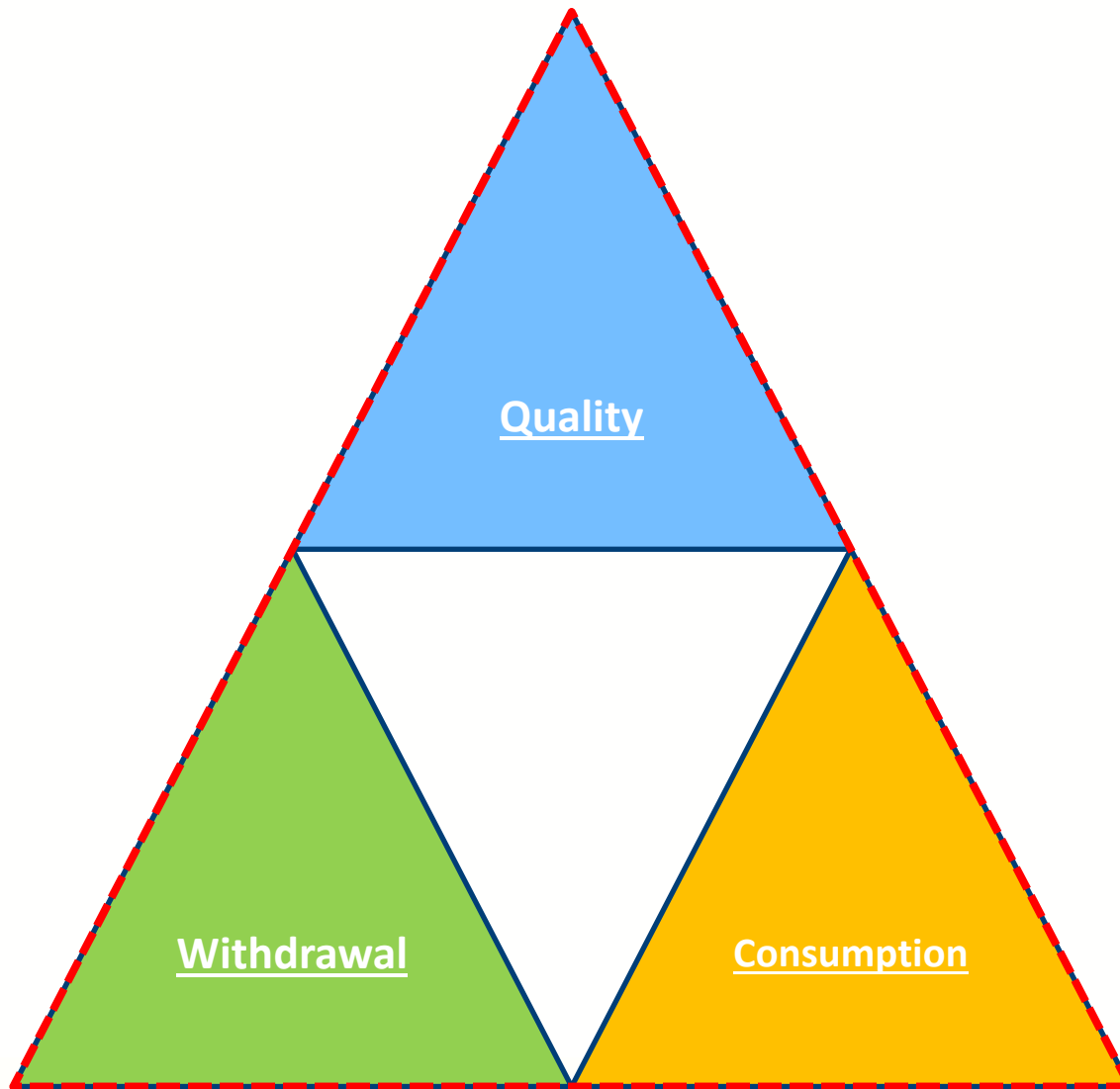
Agriculture

Water Availability

Gross Domestic Product

Population

“Water Triad”



Water-Energy Nexus

Water & Energy Nexus

WITHDRAWALS

“US Water Withdrawals by the Numbers”

29.4



19.2

138.8

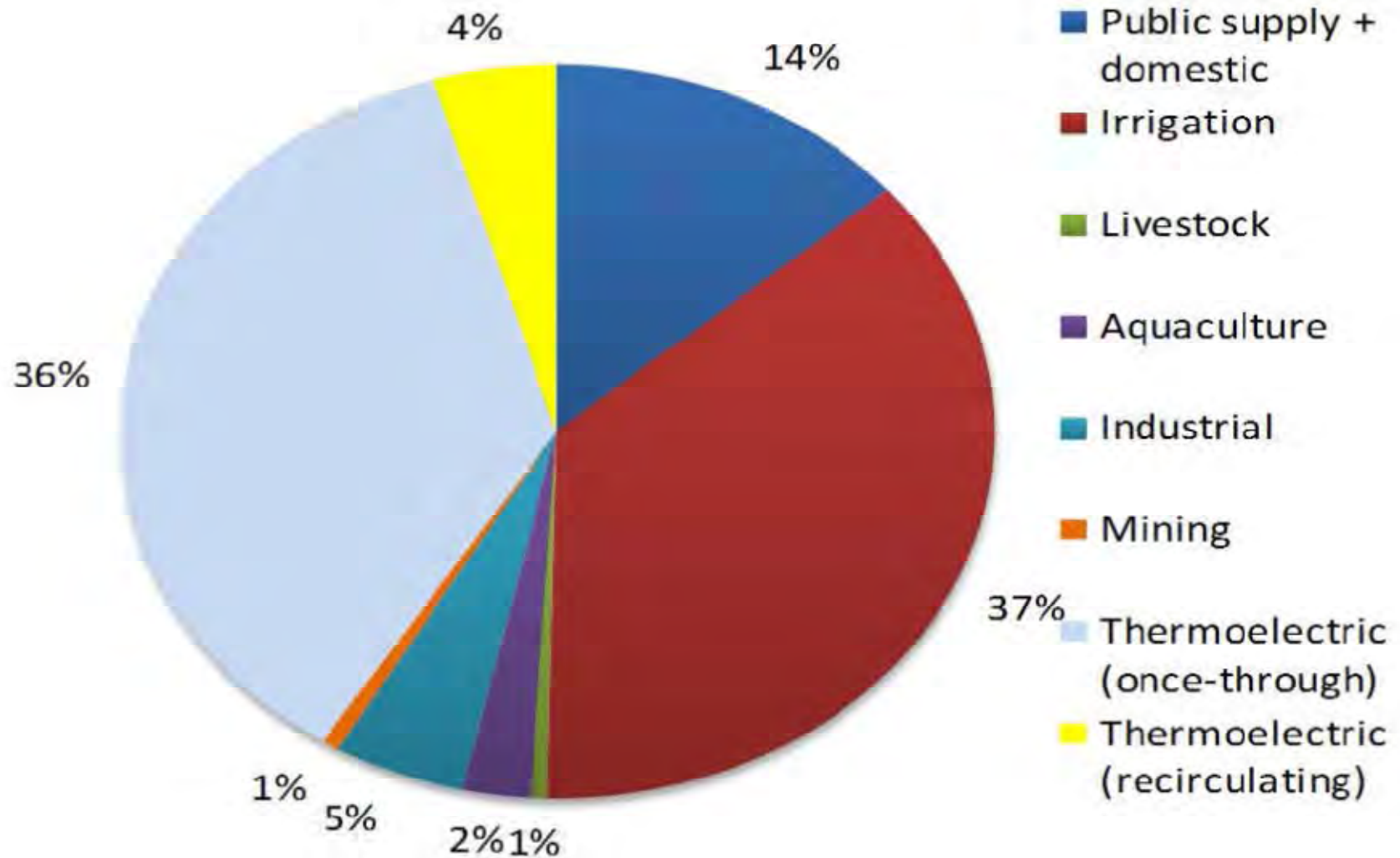


142.0



330

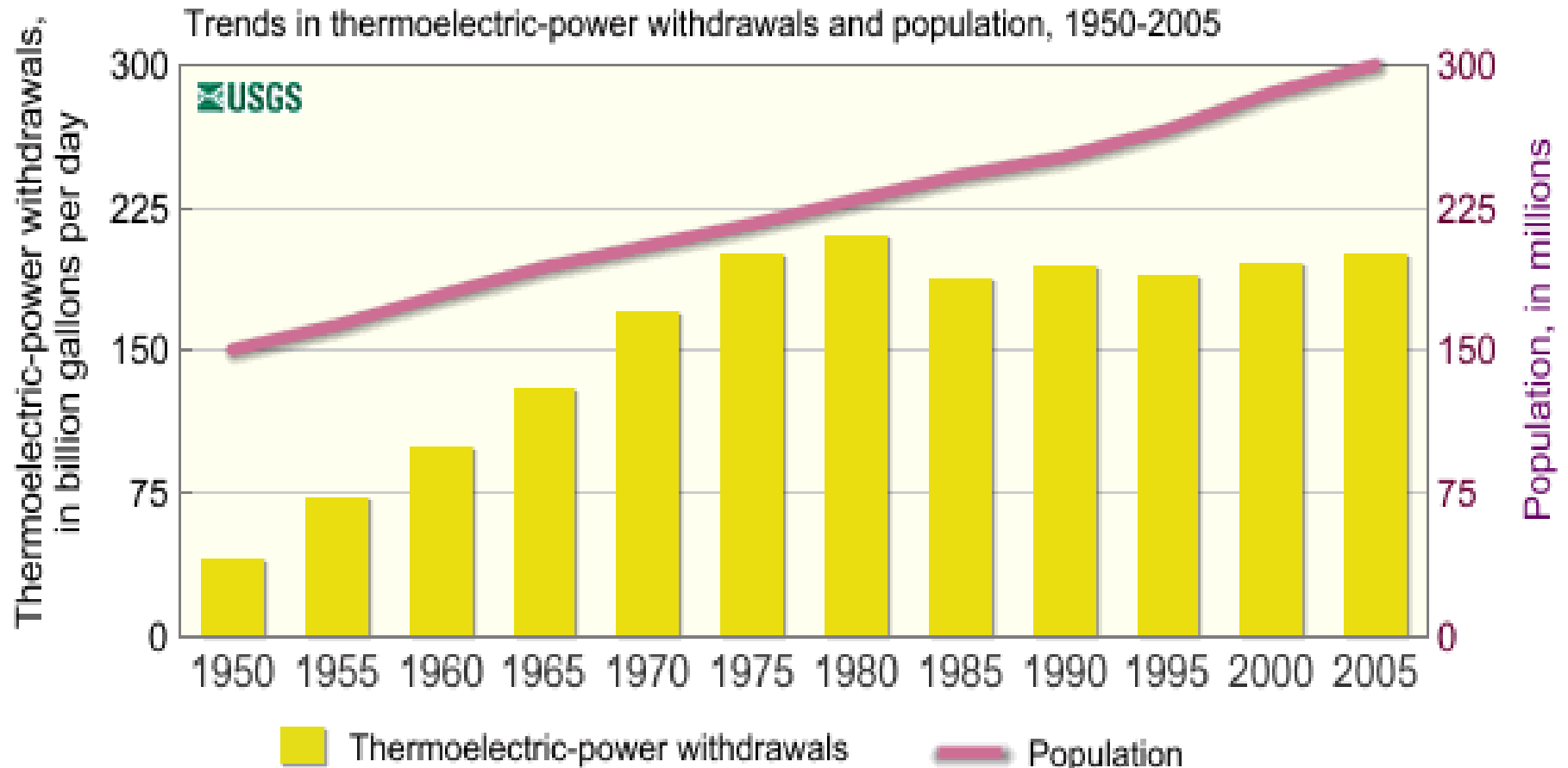
“US Water Withdrawals by Sector”



Source: Water Use for Electricity Generation and Other Sectors: Recent Changes (1985-2005) and Future Projections (2005-2030) EPRI Report: 1023676 published November 2011.

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“US Energy – Population Trends”

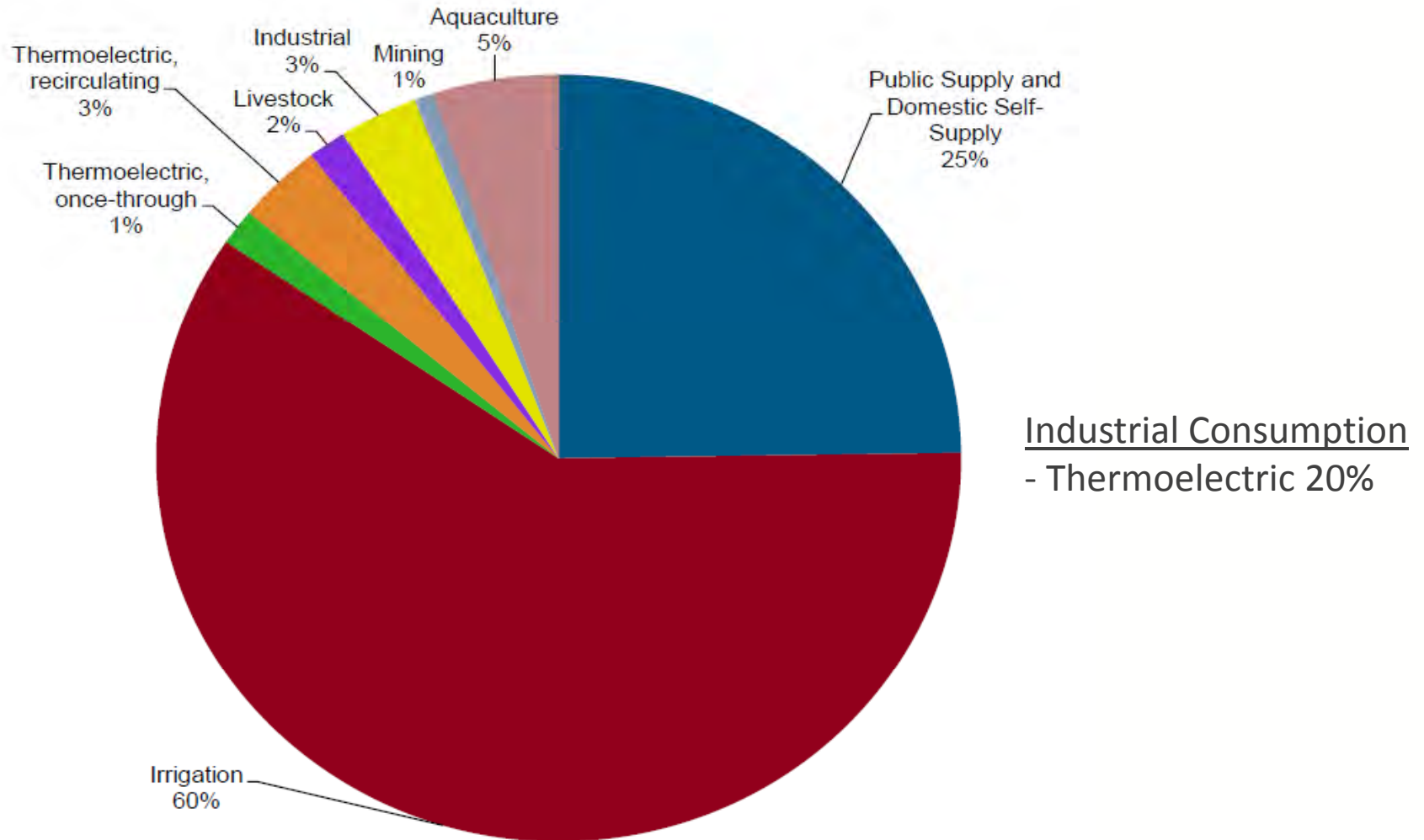


Estimated use of water in the United States in 2005
2009, Kenny, Joan F.; Barber, Nancy L.; Hutson, Susan S.; Linsey, Kristin S.; Lovelace,
John K.; Maupin, Molly A.
USGS Circular: 1344

Water & Energy Nexus

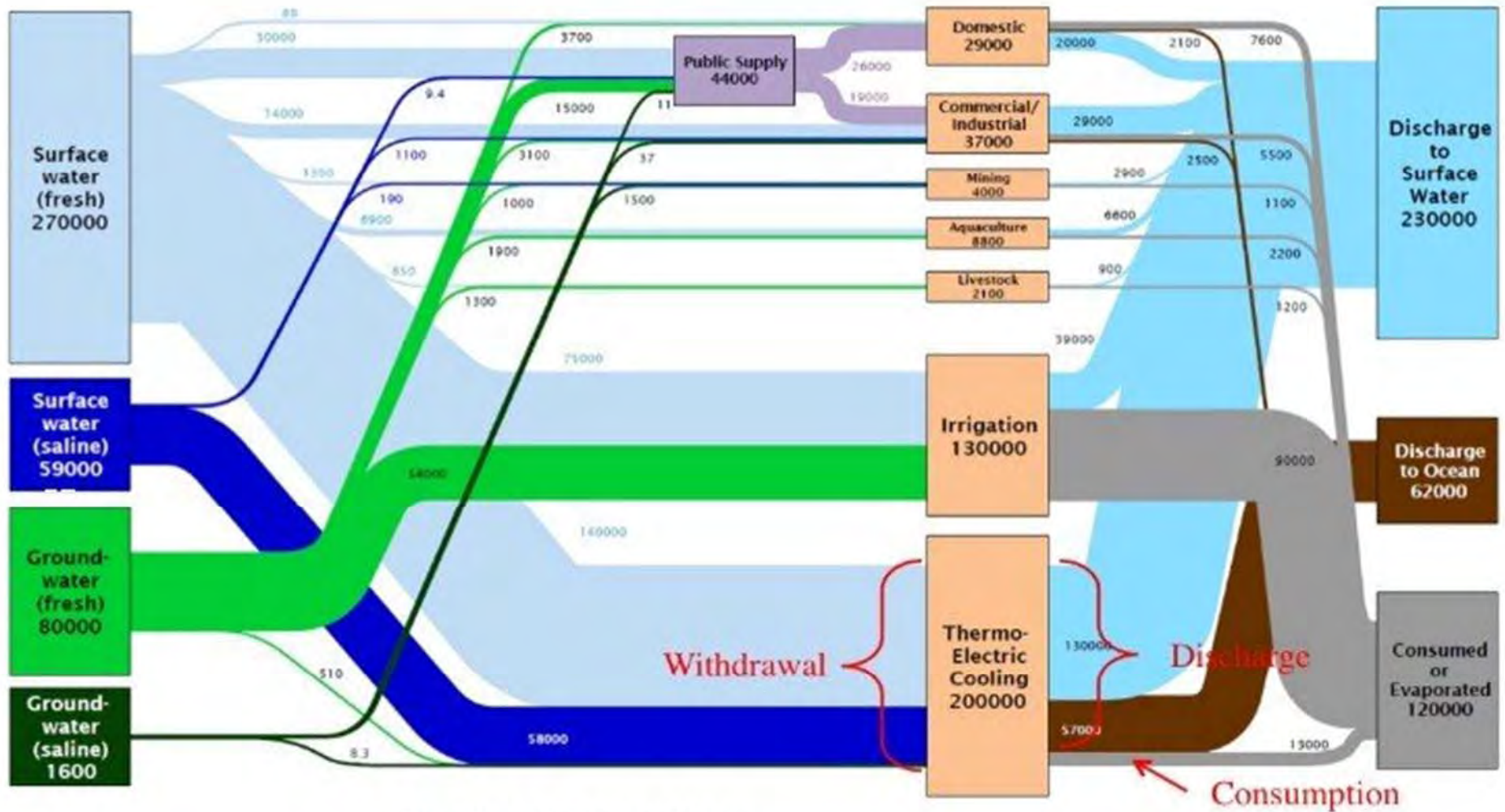
CONSUMPTION

“US Water Consumption by Sector”



Source: Water Use for Electricity Generation and Other Sectors: Recent Changes (1985-2005) and Future Projections (2005-2030) EPRI Report: 1023676 published November 2011.

“2005 US Water Consumption by Sector”



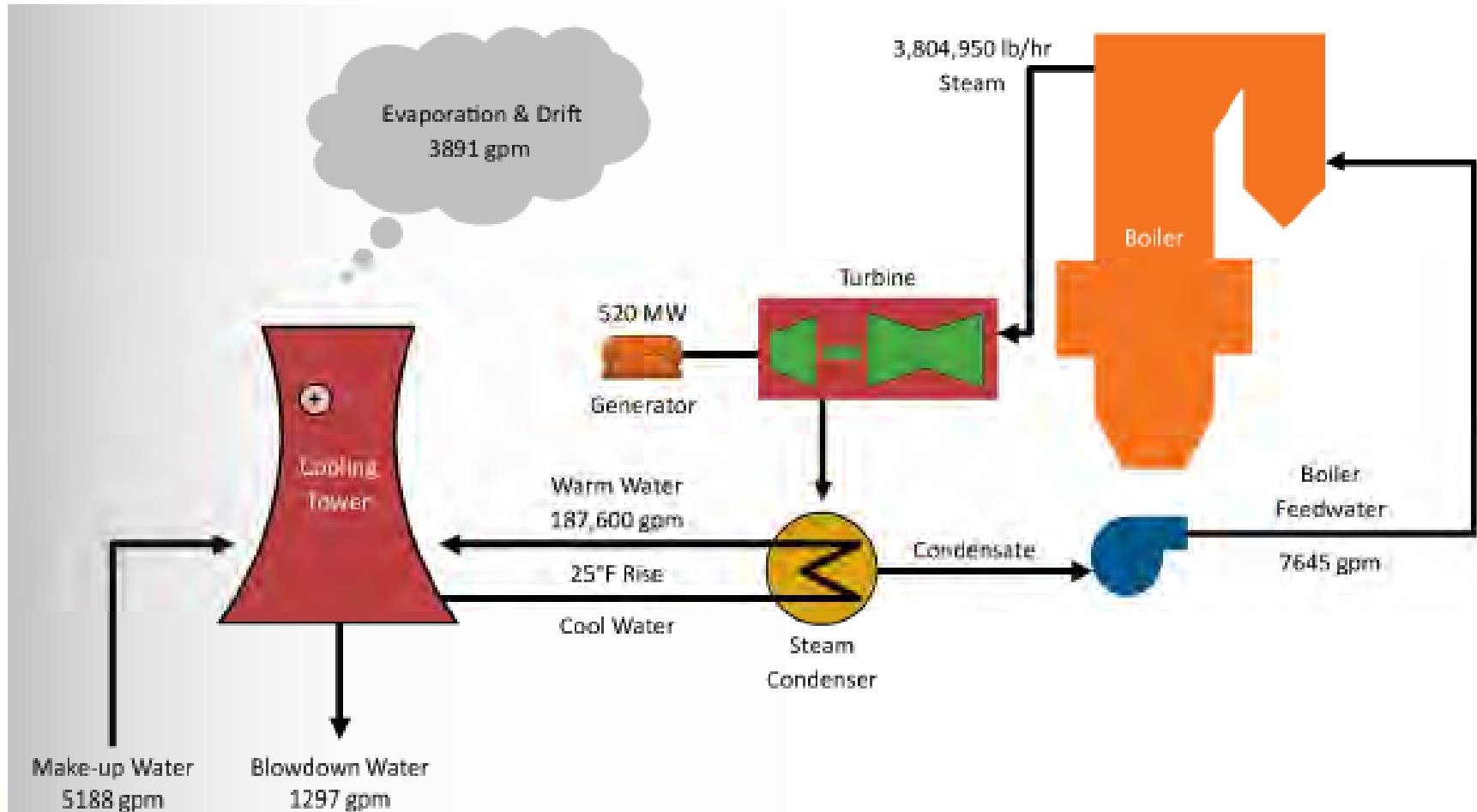
Source: Department of Energy & Lawrence Livermore National Labs, 2011.
 Data from USGS Circular 1344, 2009.

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Water & Energy Nexus

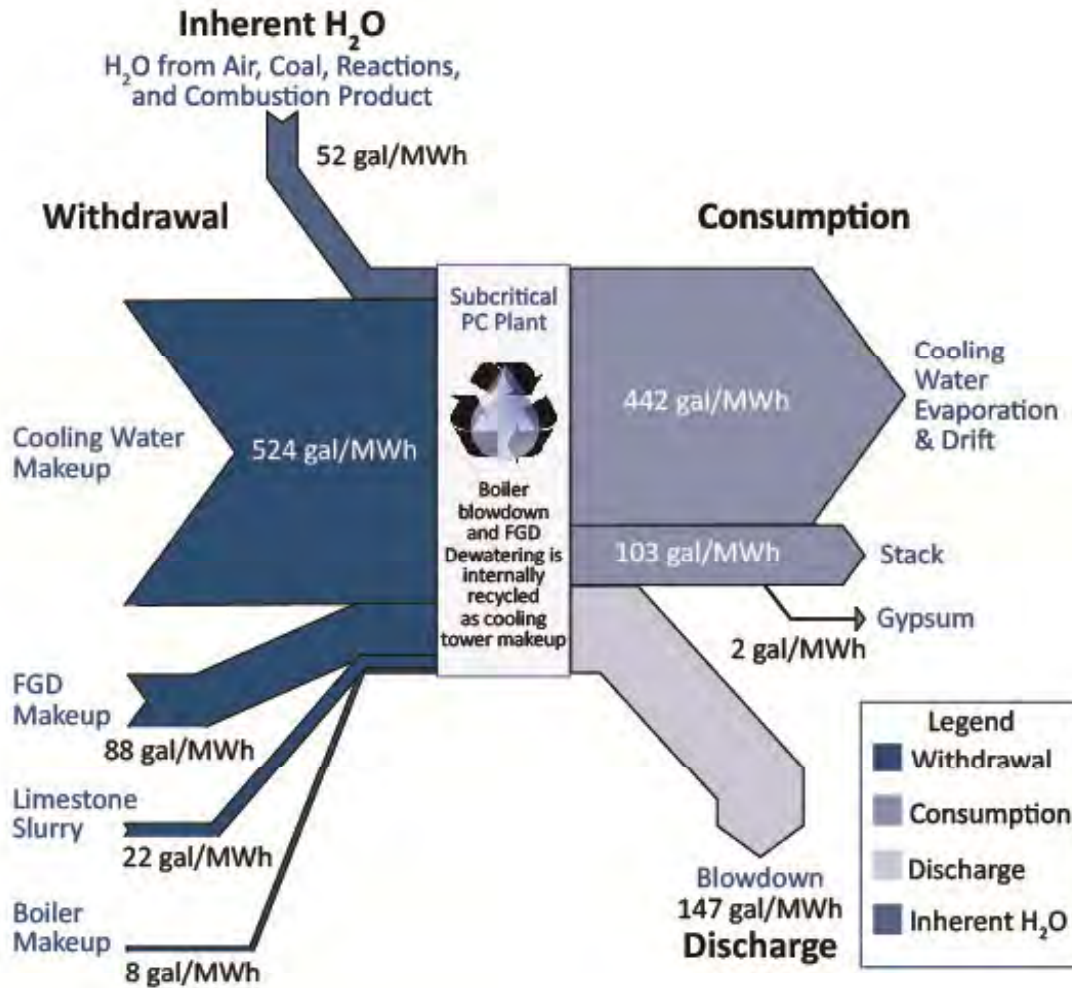
THERMOELECTRIC CONSUMPTION

Water Balance for 520MW Bituminous Coal Fired Power Plant



Source: NETL Power Plant Water Usage and Loss Study, May 2007

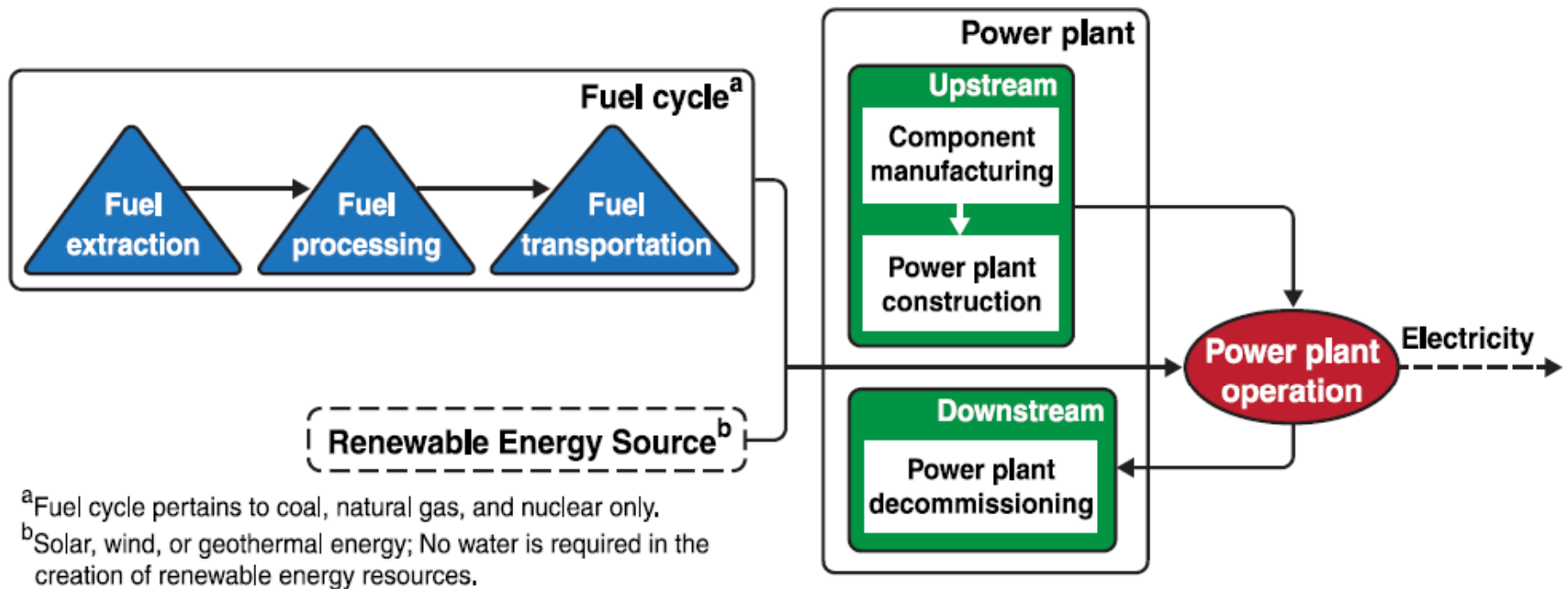
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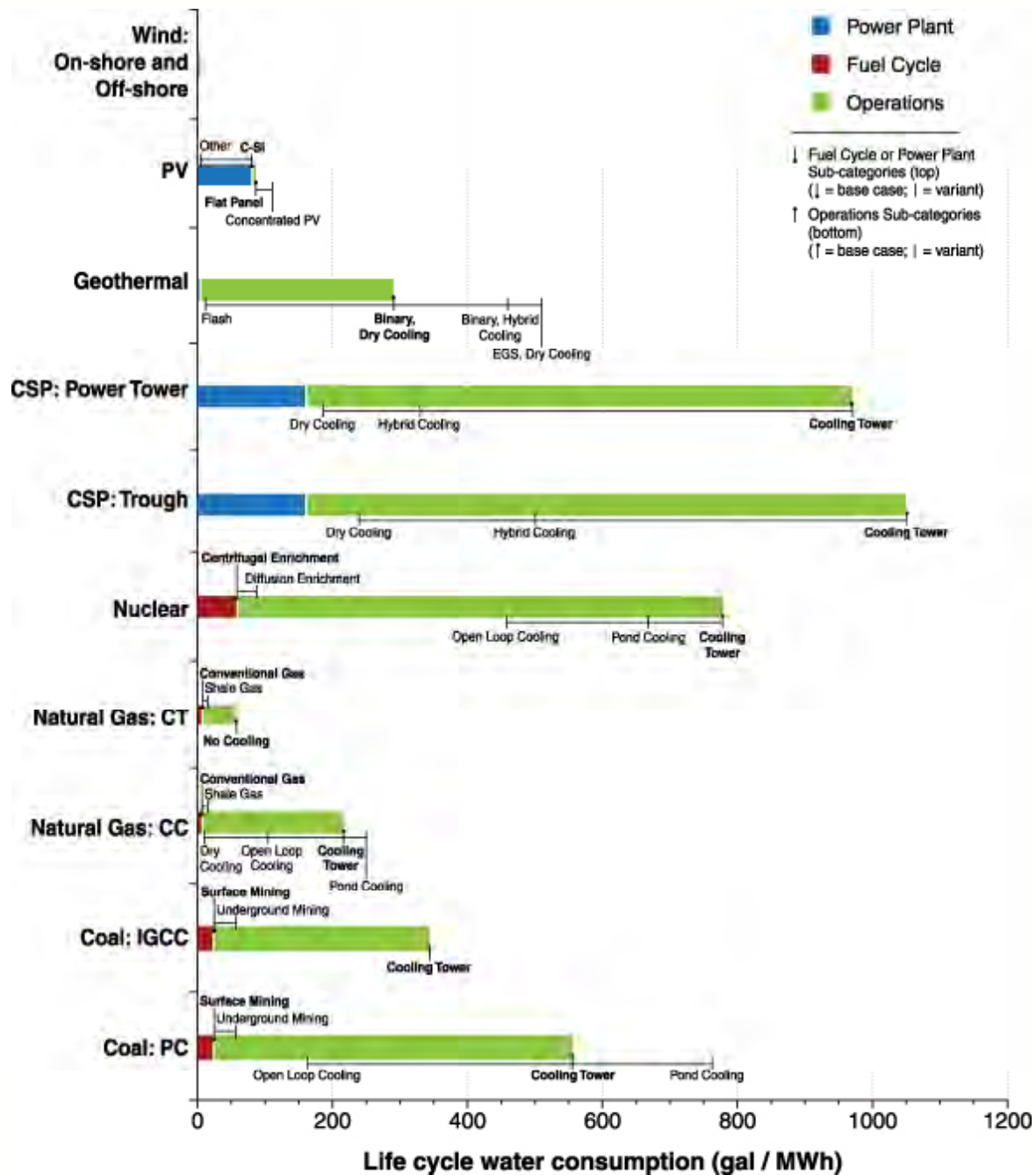
Sankey Diagram : Water Balance on a 500 MW subcritical, pulverized coal power plant with Cooling Tower and wet FGD

Source: Carney et al. "Exploring the Possibilities" The NETL Power Plant Water Program" The Department of Energy – National Energy Technology Laboratory Cornerstone Mag. Volume 2 Issue 1. April 2014

Life Cycle Water Use in Thermoelectric Power Plants



Lifetime Thermoelectric Water Efficiency



Meldum, et al. "Lifecycle water use for electricity generation: a review and harmonization of literature estimates" *Environ. Res. Letters* 8 (2013)

Water & Energy Nexus

WATER QUALITY

Environmental Protection Agency

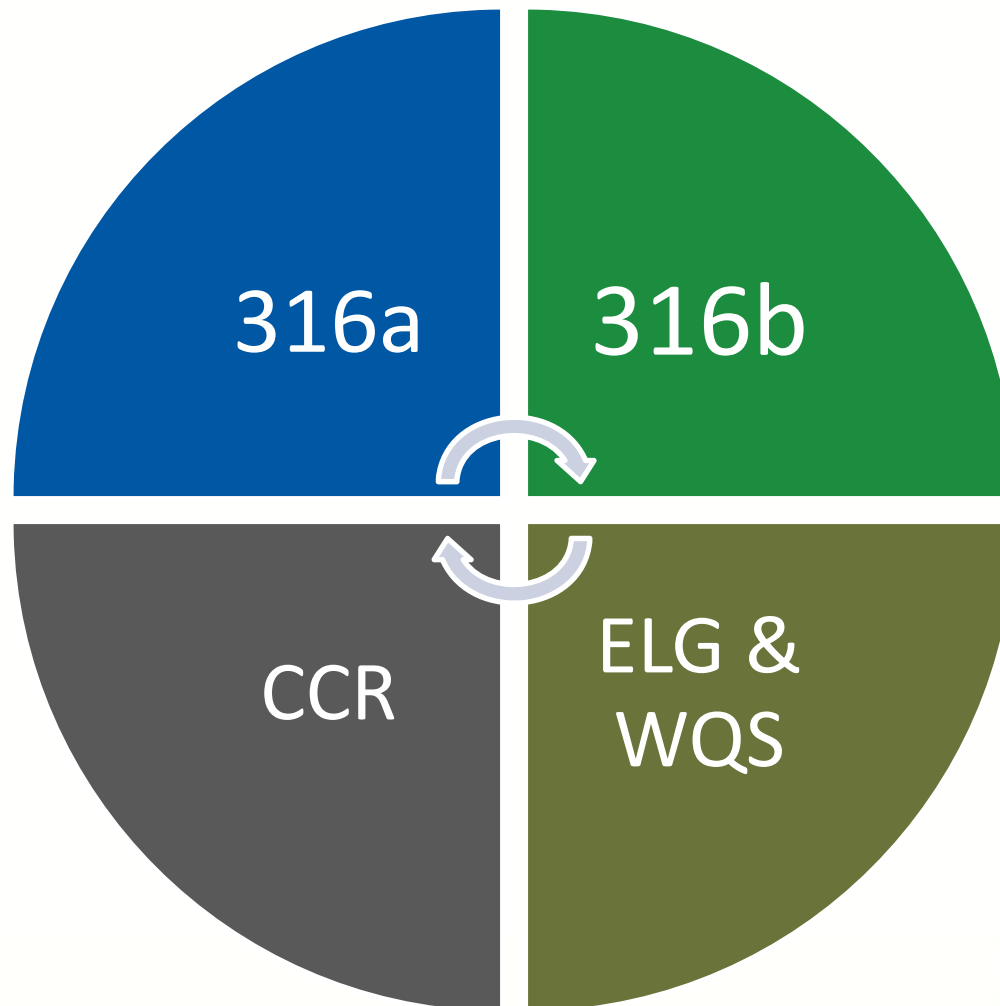
Protecting Water: A Precious, Limited Resource:

Given the nation's significant water infrastructure needs and substantial evidence that progress in advancing clean water and safe drinking water goals in the U.S. is stalled, there is a clear need to reinvigorate efforts to improve water quality. By taking action to reduce uncertainties about the scope of the Clean Water Act, to employ green infrastructure and other locally driven solutions that restore degraded waterways and revitalize communities, and to focus resources to decrease pollution to our waters and protect high quality waters, we can achieve real, cost-effective solutions to our nation's water quality challenges. Simultaneously, our efforts will protect drinking water from known and emerging contaminants that endanger public health. Achieving these results requires new paradigms including state, tribal, city roles and incentives for local action. EPA realizes that we are not the only entity engaged and investing in this critical work. To complement these efforts and enhance our ability to fulfill our mission, we will coordinate closely with local, state, and regional stakeholders, including elected officials, industry, non-governmental organizations, and environmental entities.



Gina McCarthy
EPA Administrator

“Protecting Water Quality & Thermoelectric Power Plants”



Water & Energy Nexus

THERMOELECTRIC WATER TRENDS

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Department of Energy

Research, Development, Demonstration & Deployment

Energy for & From Water



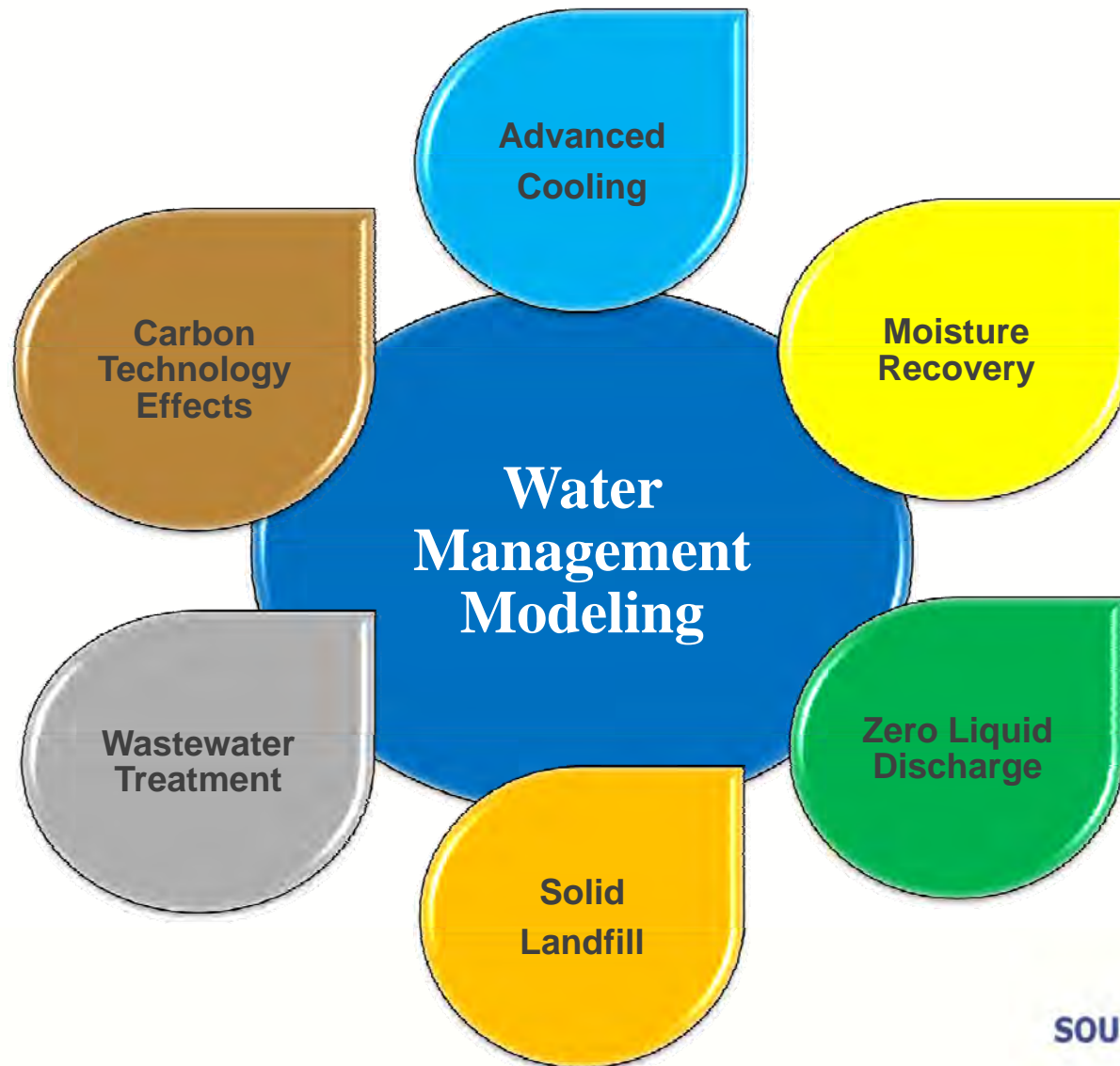
- Desalination / Membrane Distillation
- UV-LED Disinfection

Water for Energy



- Super Critical CO₂ Recompression Closed BC
- Hybrid Cooling System
- AUSC (1400 F / 5000psi)
- Water Recycling

EPRI Water Research Center at Georgia Power Company's Plant Bowen



Astoria Natural Gas Combined Cycle

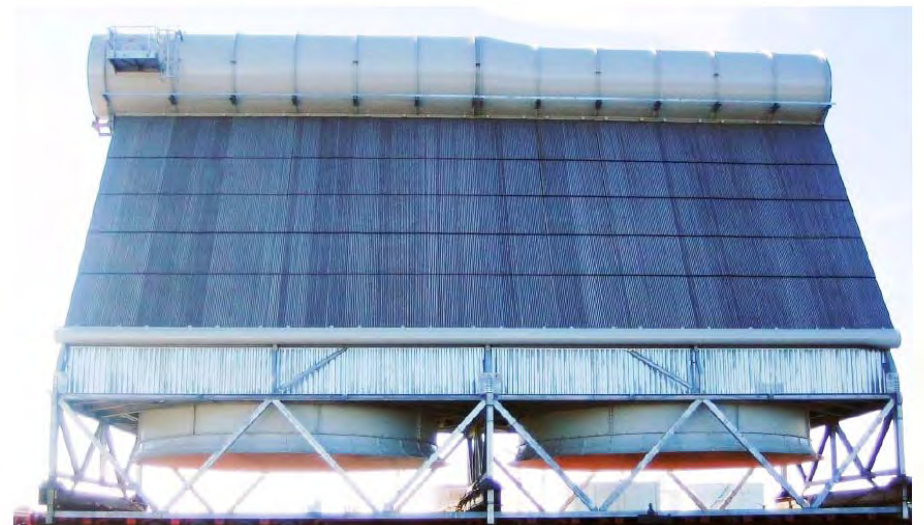
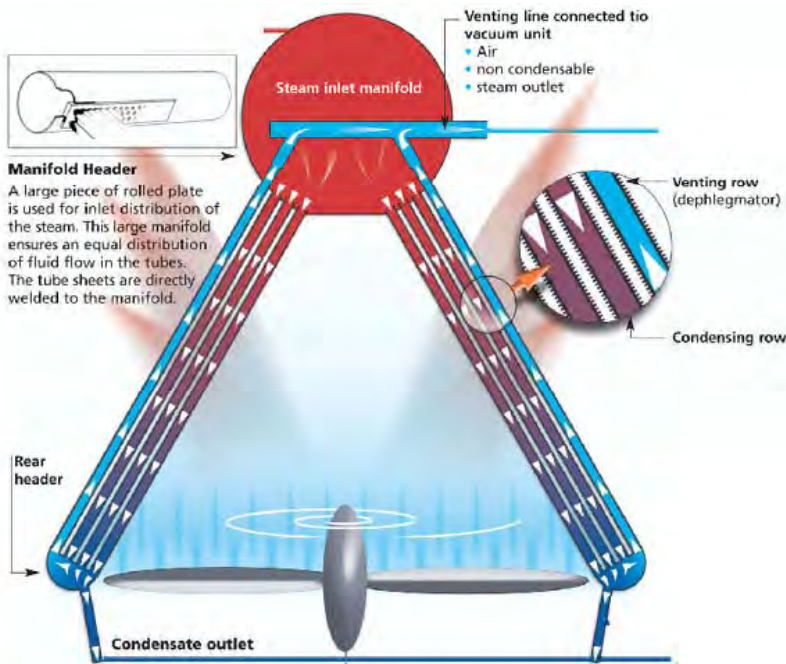
circa 2006 & 2010



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Astoria Natural Gas Combined Cycle

Air Cooled Condenser Technology



Plant Crist – Cooling and Wet FGD

- Reclaimed water from Emerald Coast Utilities Authority (EUCA), a nearby water treatment company
- Gulf Power has surpassed 7.7 billion gallons in the amount of treated water used at Plant Crist north of Pensacola. The plant uses the water as a cooling agent & operate the scrubber system.
- Avoids Plant Crist from taking millions of gallons of water every day from the Escambia River
- Establishes the ECUA Central Water Reclamation Facility as zero discharge.
- Removes millions of gallons a day of effluent discharged into Pensacola Bay from the Main Street facility.
- Provides consistent water quality for the scrubber vessel and the cooling towers.
- Reclaimed water available for other plant uses.



Kemper County IGCC

- Zero Liquid Discharge facility.
- Water treatment units will process any wastewater generated in the process for re-use within the plant.
- Treated effluent from the city of Meridian will provide makeup water required.



Water – Energy Nexus

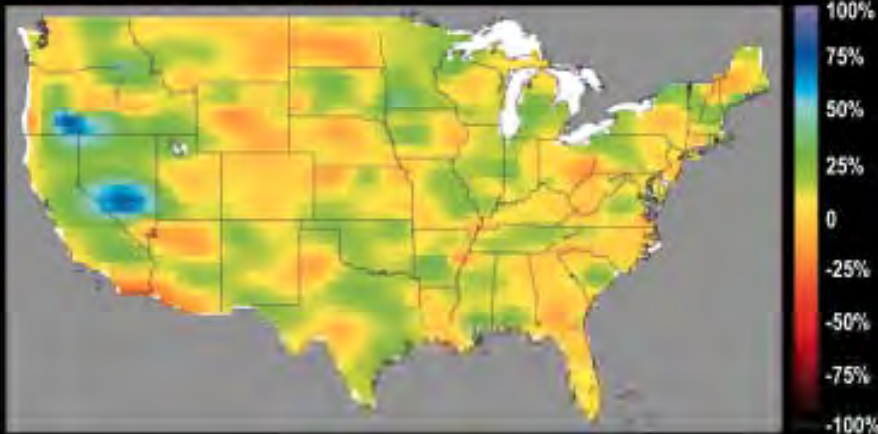
LINK TO GLOBAL CLIMATE CHANGE

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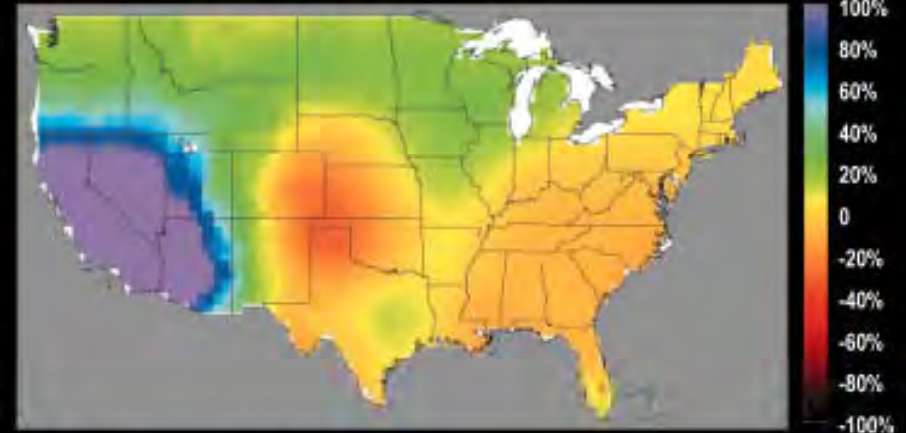
“Link to Global Climate Change”

Precipitation Change

Observed 20th Century



Canadian Model 21st Century



Hadley Model 21st Century

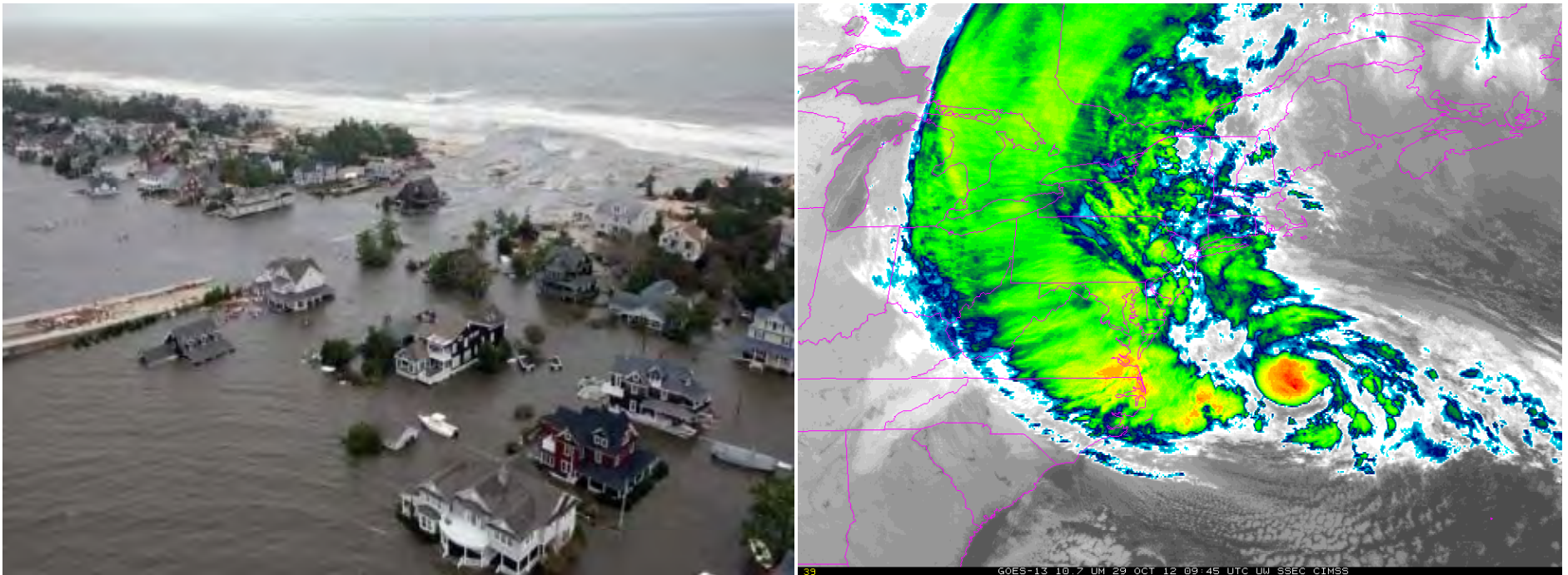


Significant increases in precipitation have occurred across much of the US in the 20th century. Some localized areas have experienced decreased precipitation. The Hadley and Canadian model scenarios for the 21st century project substantial increases in precipitation in California and Nevada, accelerating the observed 20th century trend (some other models do not simulate these increases). For the eastern two-thirds of the nation, the Hadley model projects continued increases in precipitation in most areas. In contrast, the Canadian model projects decreases in precipitation in these areas, except for the Great Lakes and Northern Plains, with decreases exceeding 20% in a region centered on the Oklahoma panhandle. Trends are calculated relative to the 1961-90 average.

Source: “US Global Change Research Information Office (GCRIO): National Assessment of the Consequences of Climate Change Report” 2000.

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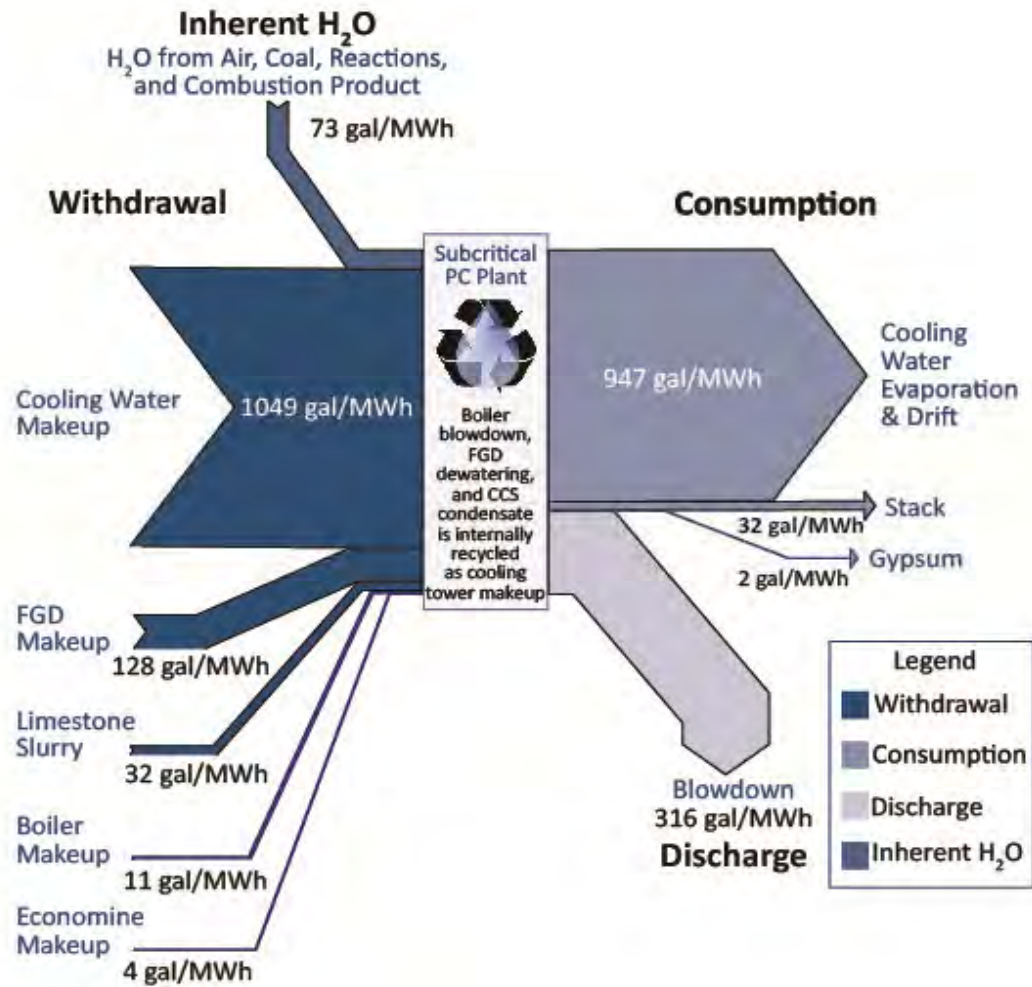
“Link to Global Climate Change”



On the evening of October 29, 2012, Hurricane Sandy made landfall in southern New Jersey

Thank You!

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Sankey Diagram : Water balance on a subcritical, pulverized coal, 500-MW power plant with recirculating cooling, FGD, and amine absorption-based CCS

Source: Carney et al. "Exploring the Possibilities" The NETL Power Plant Water Program"
The Department of Energy – National Energy Technology Laboratory
Cornerstone Mag. Volume 2 Issue 1. April 2014

Southern Research Institute

- Established in 1941 as an independent, not-for-profit (501-c-3) center for scientific research and development
- Key Figure: Tom Martin former CEO of Alabama Power Company
- Headquartered in Birmingham, Alabama
- Revenues of \$82.5 million in 2011
- Staff of over 500 employees
- Organized into three divisions:
 - Engineering, Environment, and Energy
 - Drug Discovery
 - Drug Development (pre-clinical)

