THE WATER ENERGY NEXUS

UNDERSTANDING THE WATER ENERGY NEXUS AND ITS IMPACT ON WATER AVAILABILITY IN OKLAHOMA

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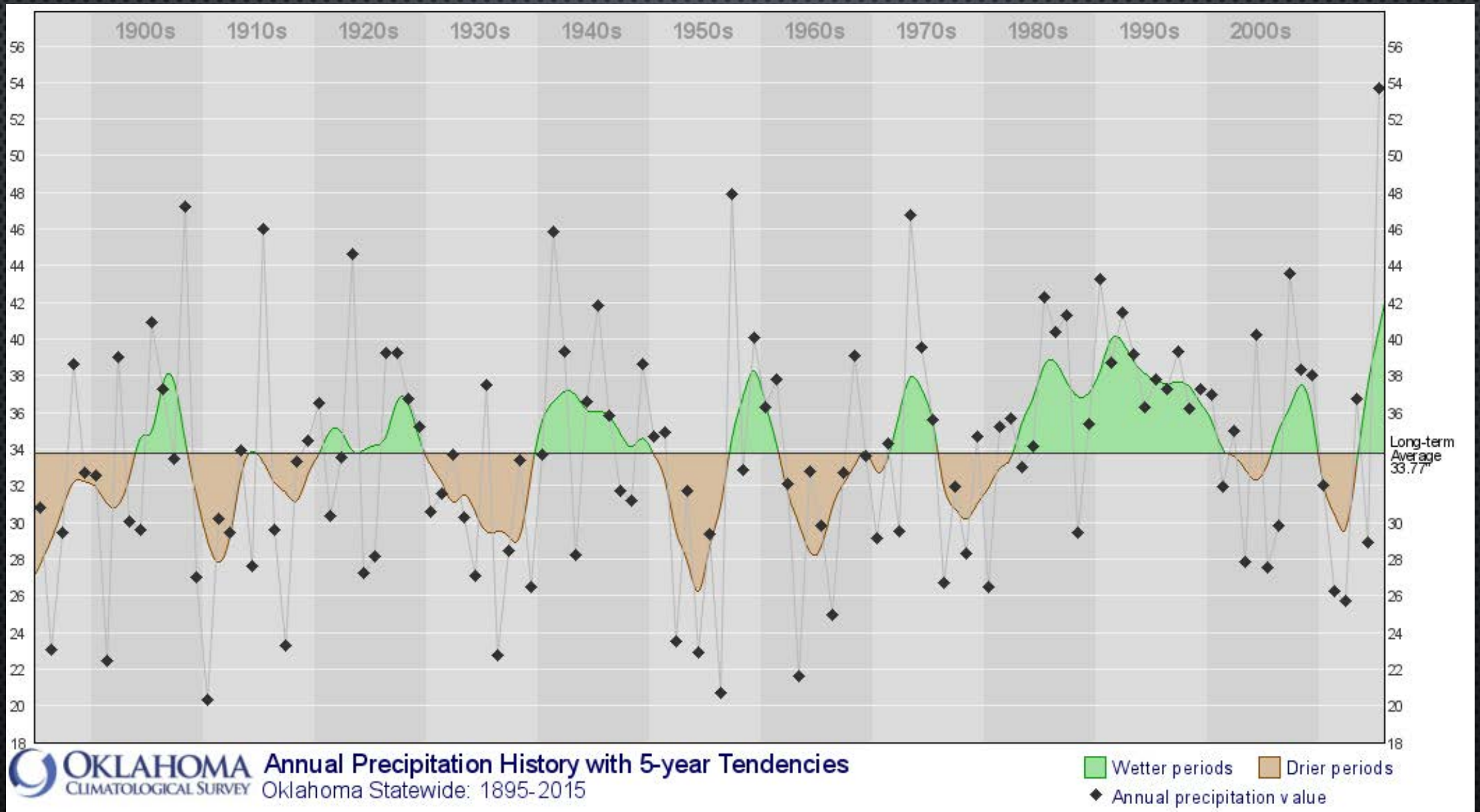
JANUARY 2017

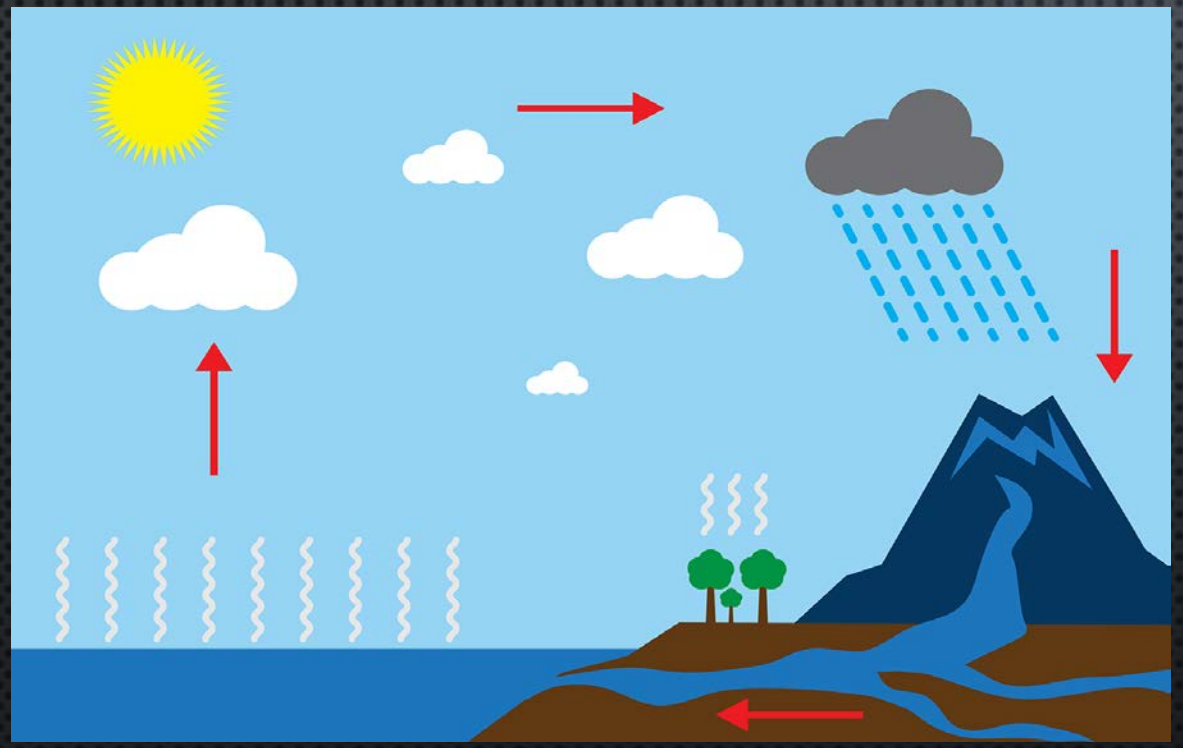
SECTION I: INTRODUCTION

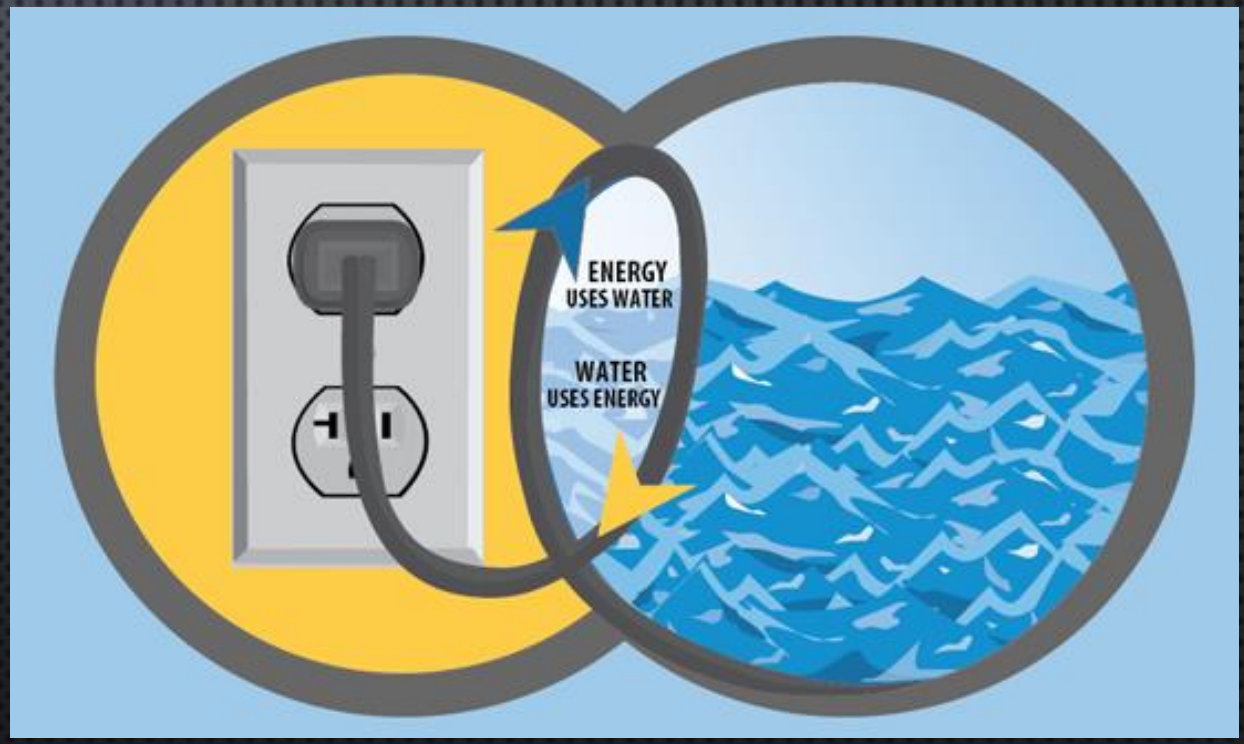
RAINFALL MAKES MEMORIES FADE FAST



WATER AVAILABILITY IS MORE THAN THE WATER CYCLE

TRADITIONAL VIEW VS MODERN VIEW

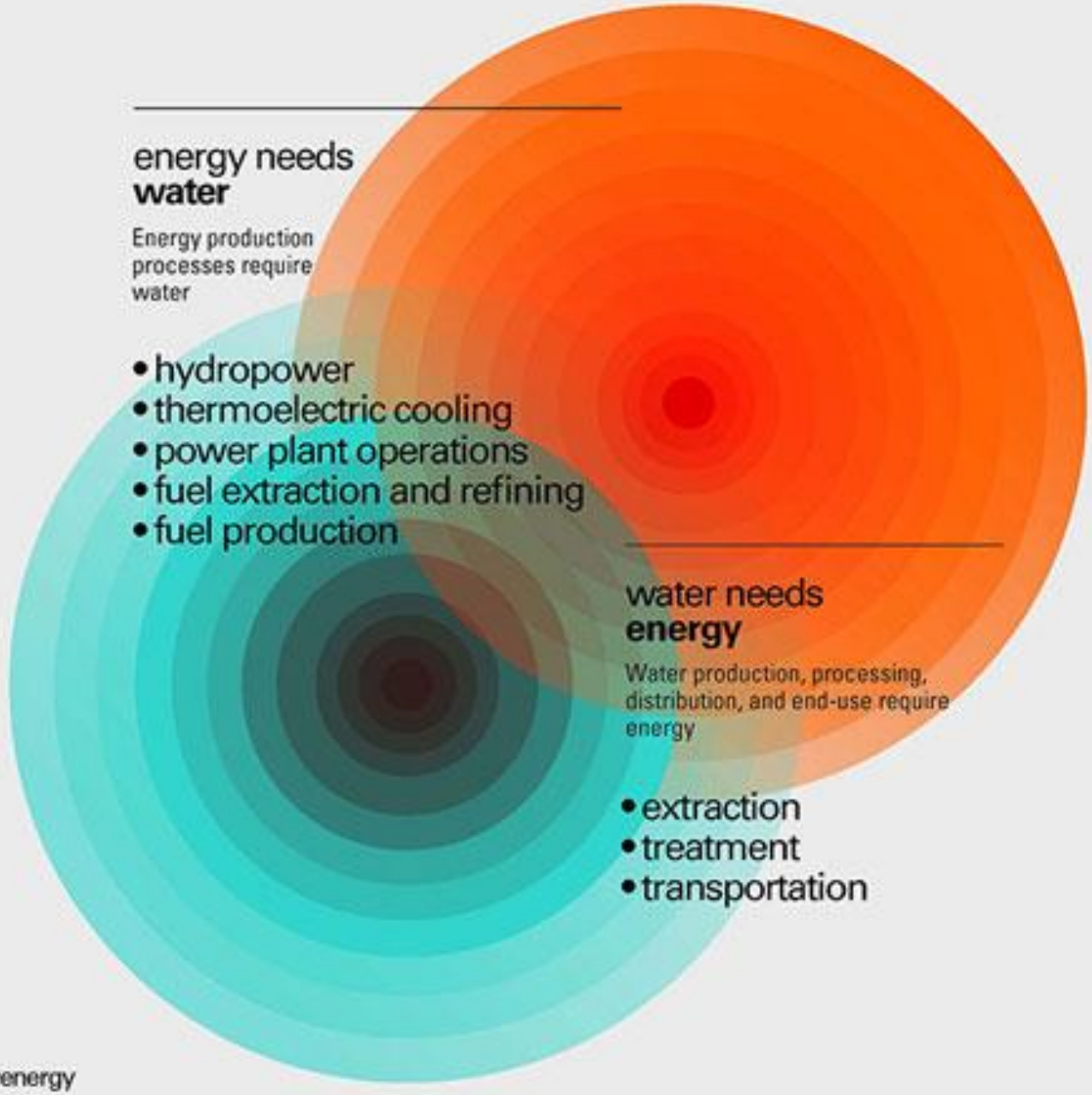




SECTION II: DEFINING THE WATER ENERGY NEXUS

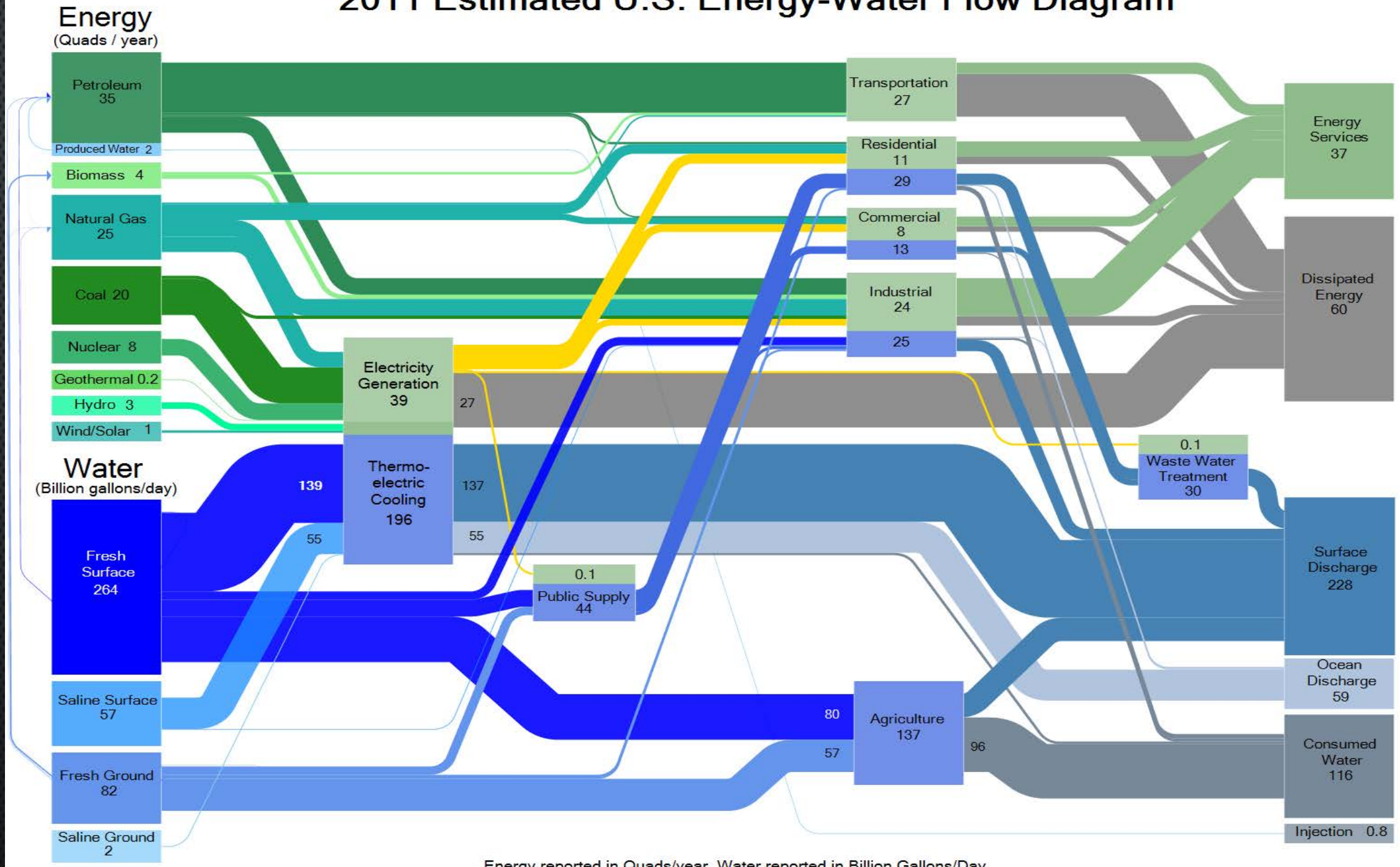
thirsty energy

energy
and water's
interdependence



WORLD BANK GROUP www.worldbank.org/thirstyenergy

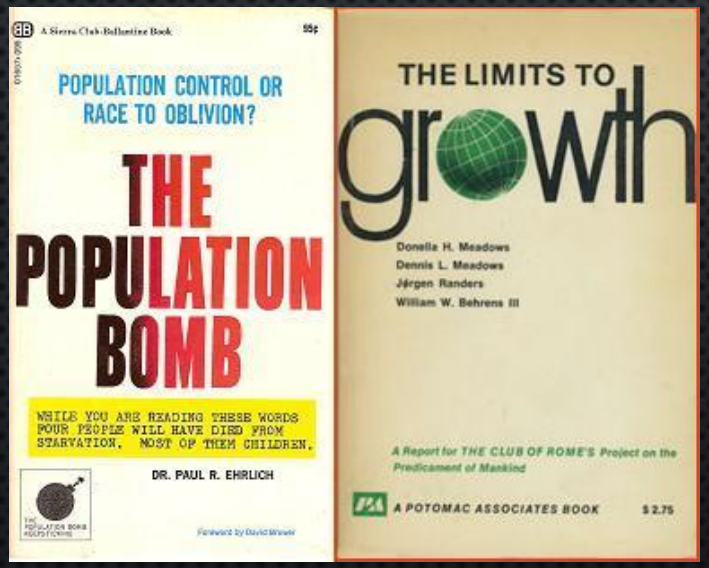
2011 Estimated U.S. Energy-Water Flow Diagram

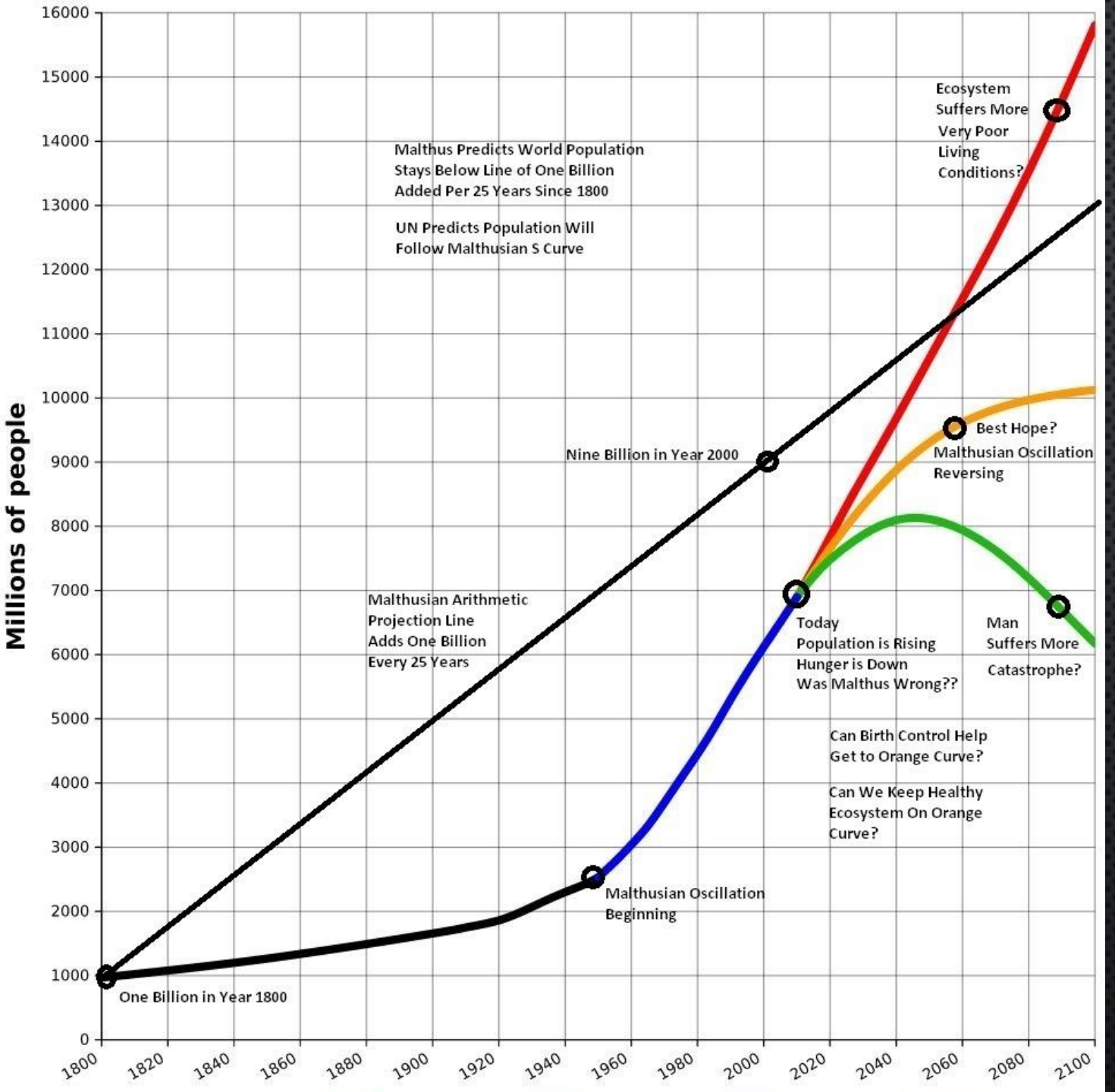


Energy reported in Quads/year. Water reported in Billion Gallons/Day.

TERM ETYMOLOGY

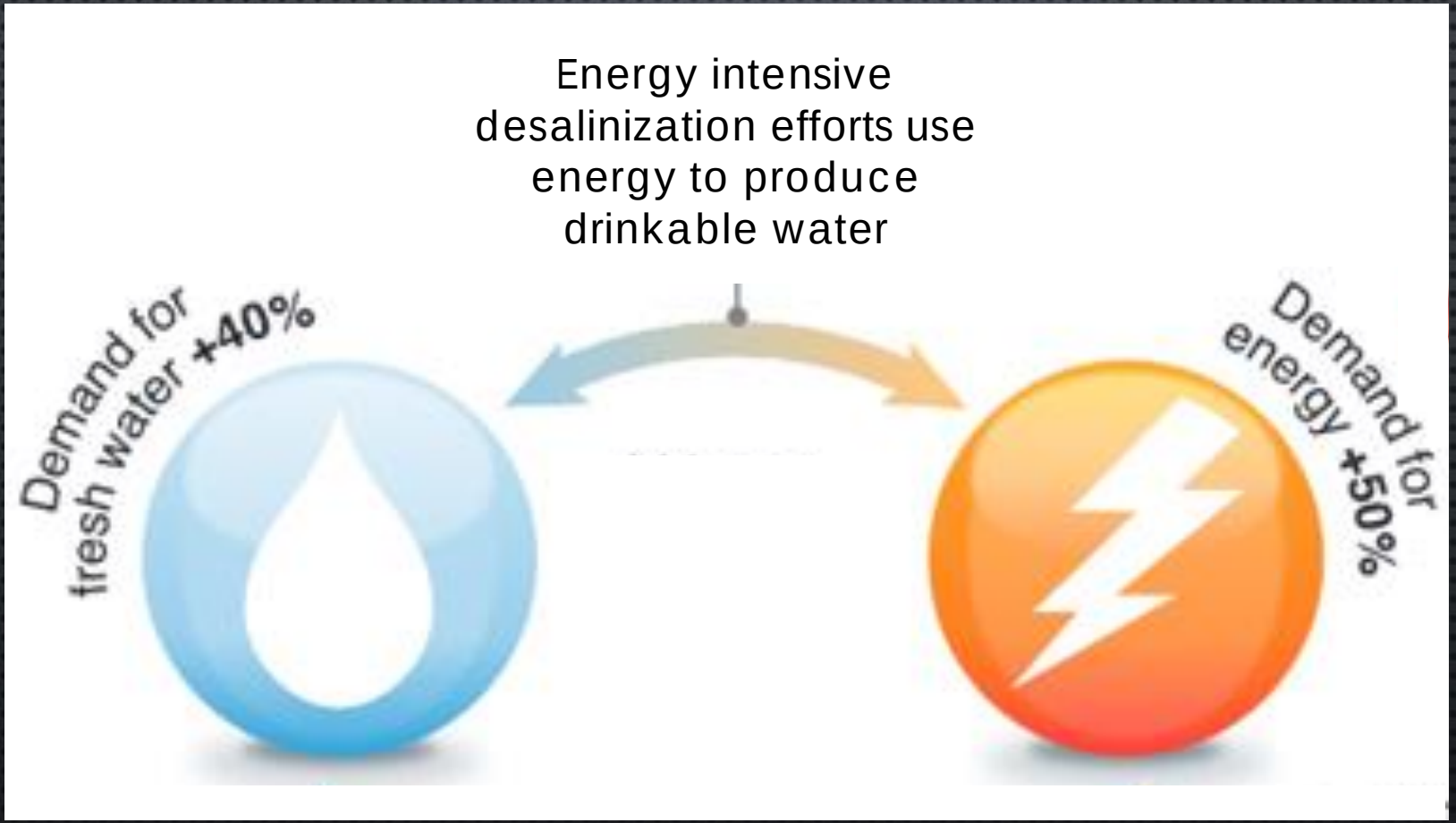
Reverund
Thomas
Robert
Malthus
c. 1798



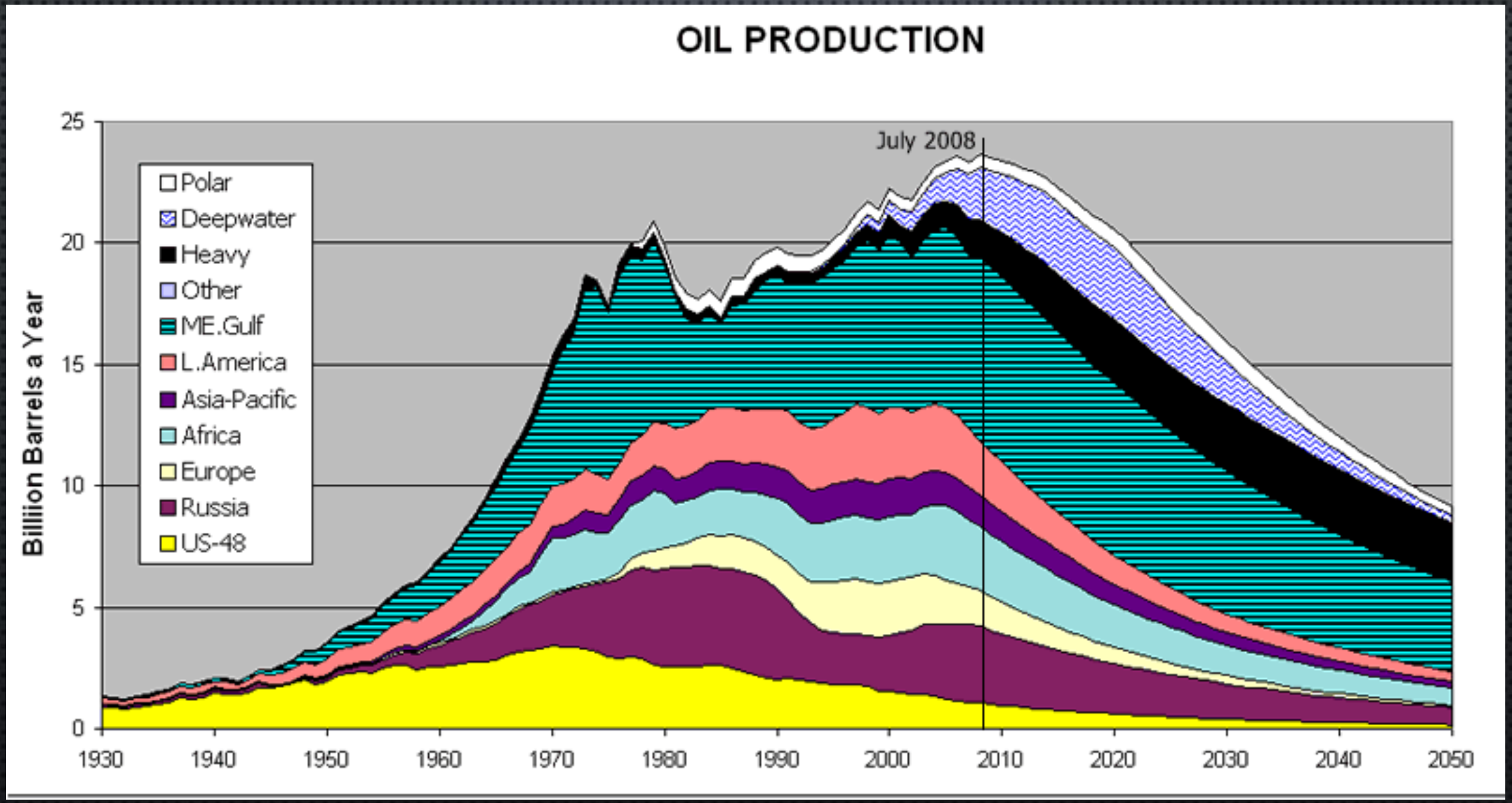


SECTION III:
THE IMPORTANCE OF UNDERSTANDING THE NEXUS

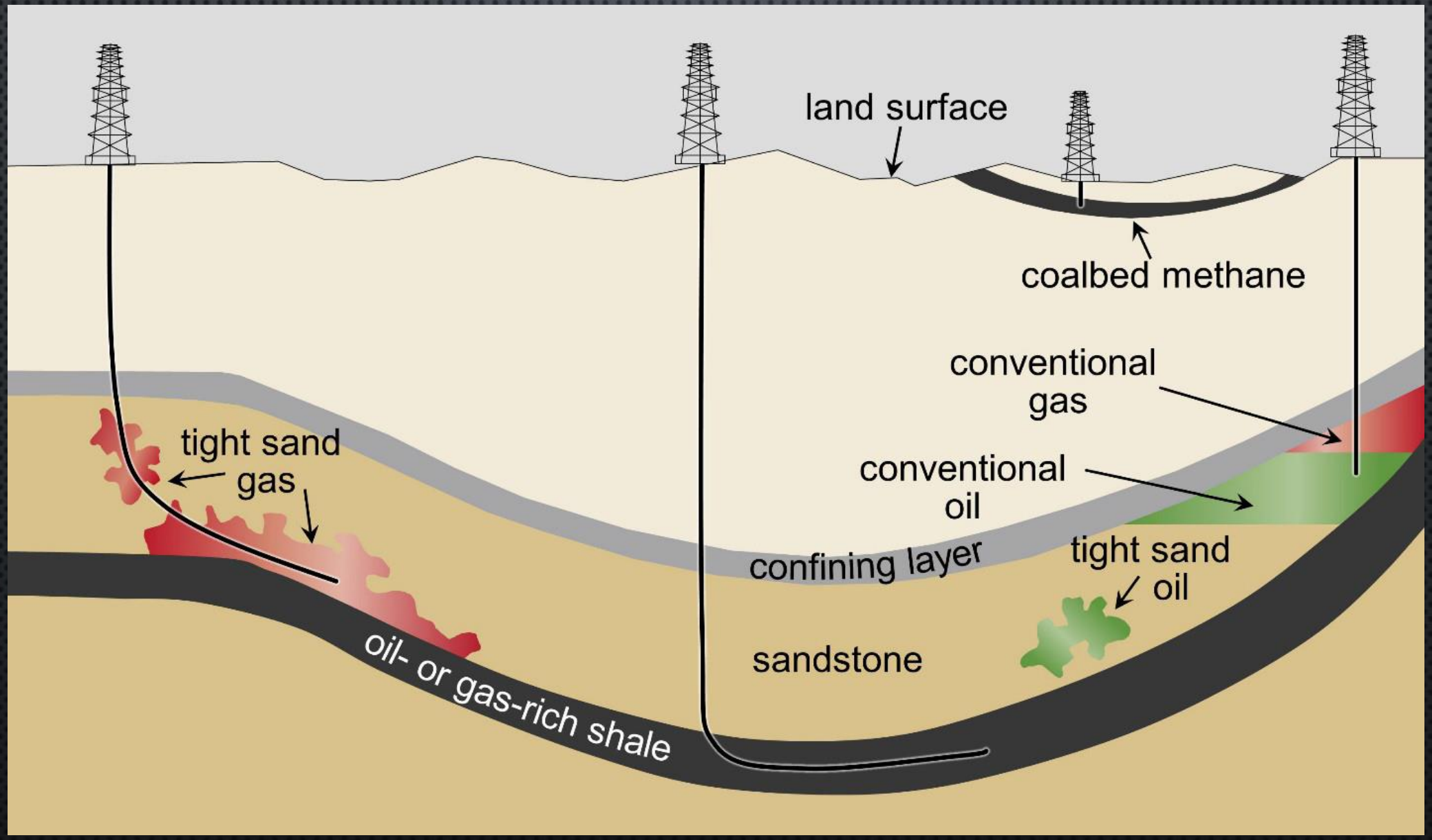
THE WATER ENERGY NEXUS IS STRESSED TO A BREAK POINT



PEAK OIL APPEARED IMMINENT AS RECENTLY AS 2008



SHALE RESOURCE EXTRACTION CHANGED TH GAME

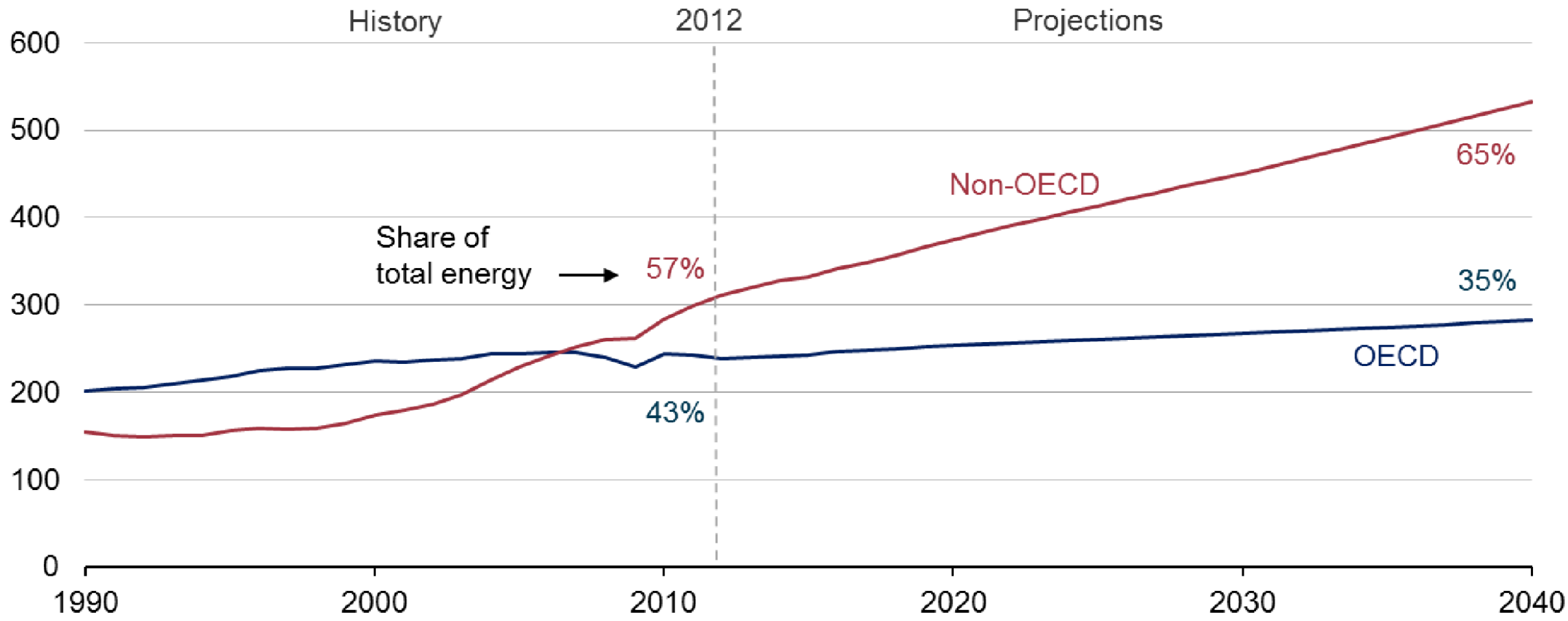


CLEAN ENERGY HAS ARRIVED FOR GOOD

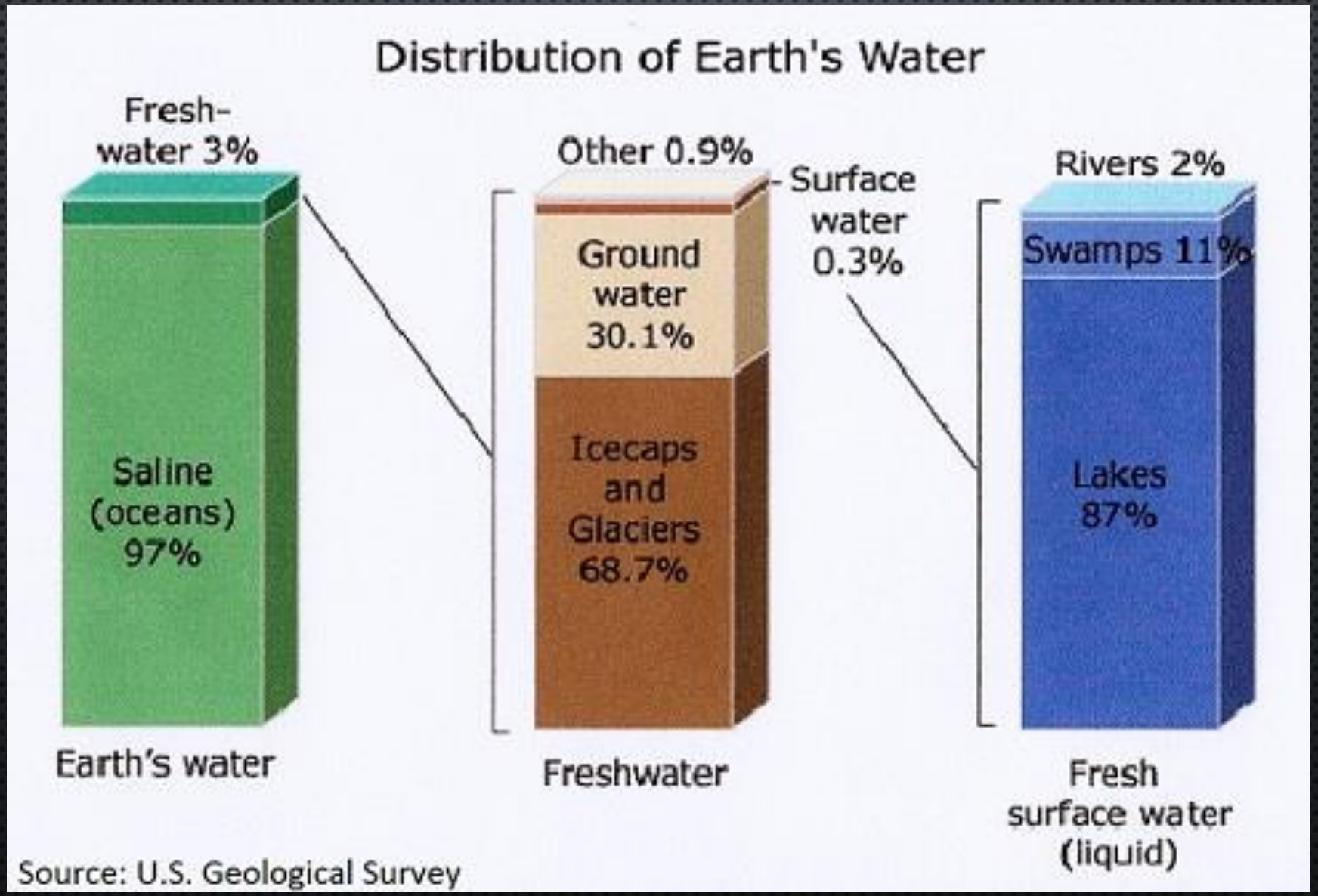
GLOBAL ENERGY SECURITY IS MERELY PERCEPTION

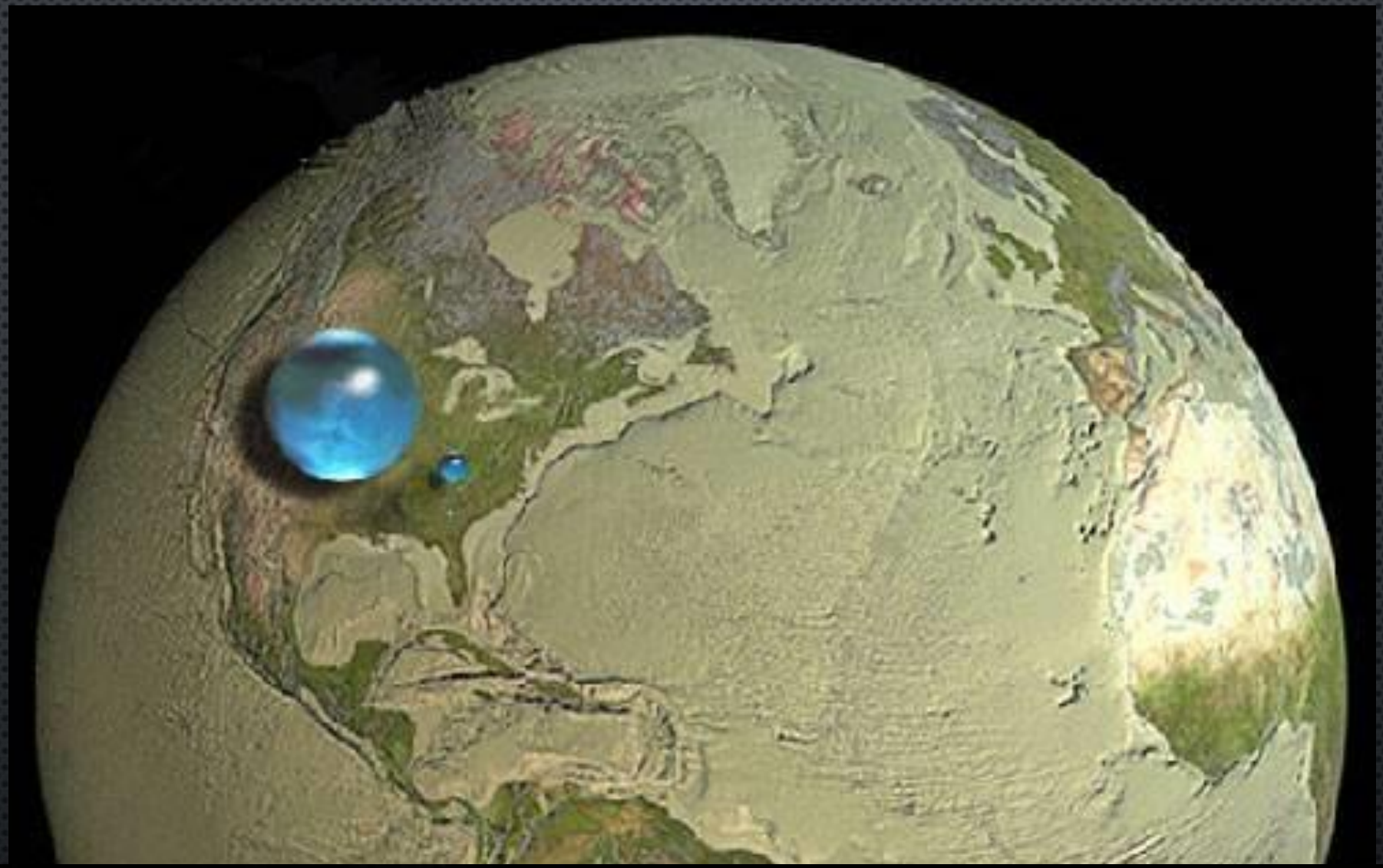
Non-OECD nations drive the increase in total energy use

Source EIA



THERE'S LESS FRESH WATER THAN YOU THINK



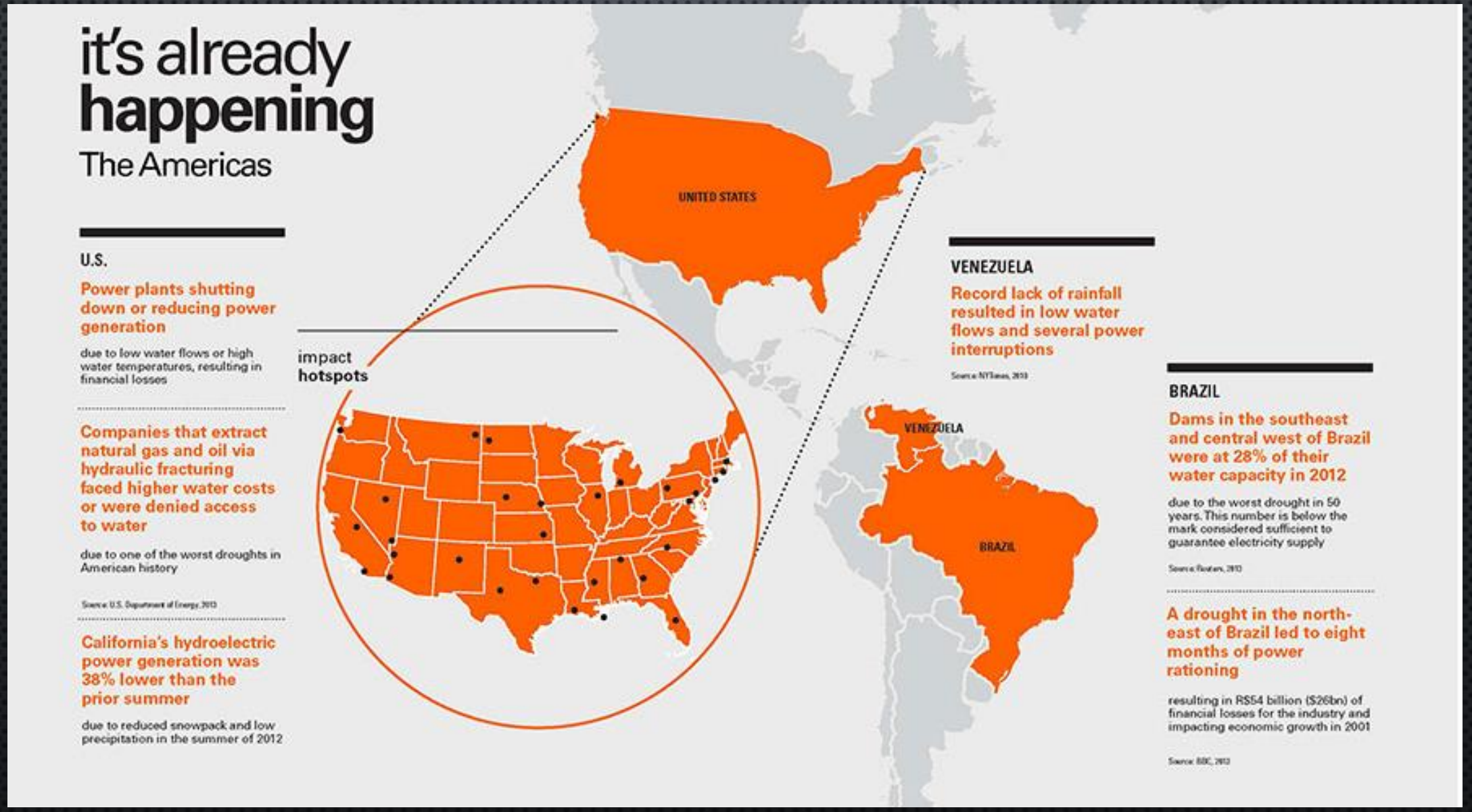


Water in, on, and above the Earth

- Liquid fresh water
- Freshwater lakes and rivers

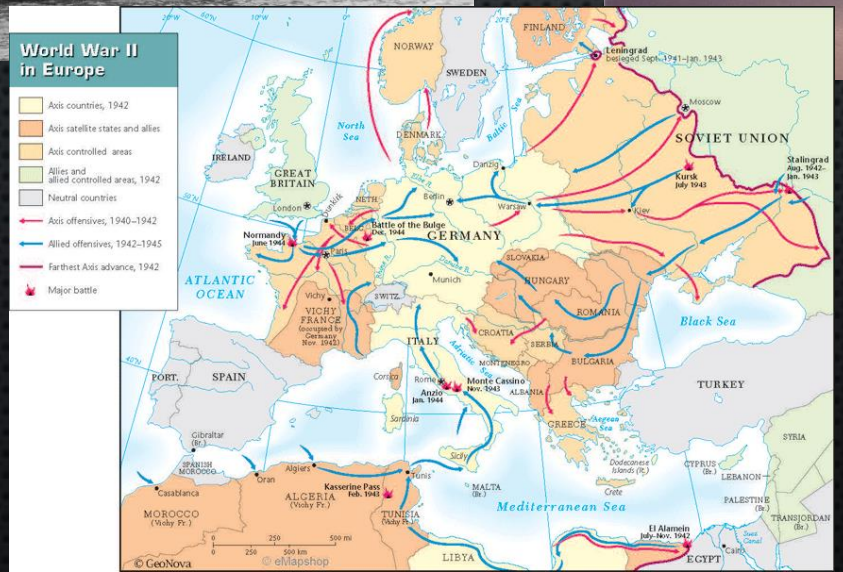
Howard Perlman, USGS
Jack Cook, Adam Nieman
Data: Igor Shiklomanov, 1993

WATER SCARCITY IS HERE MORE THAN WE REALIZE



SECTION IV:
THE RAMIFICATIONS OF A BREAKING NEXUS

CONFLICTS FROM ENERGY



CONFLICTS FROM WATER

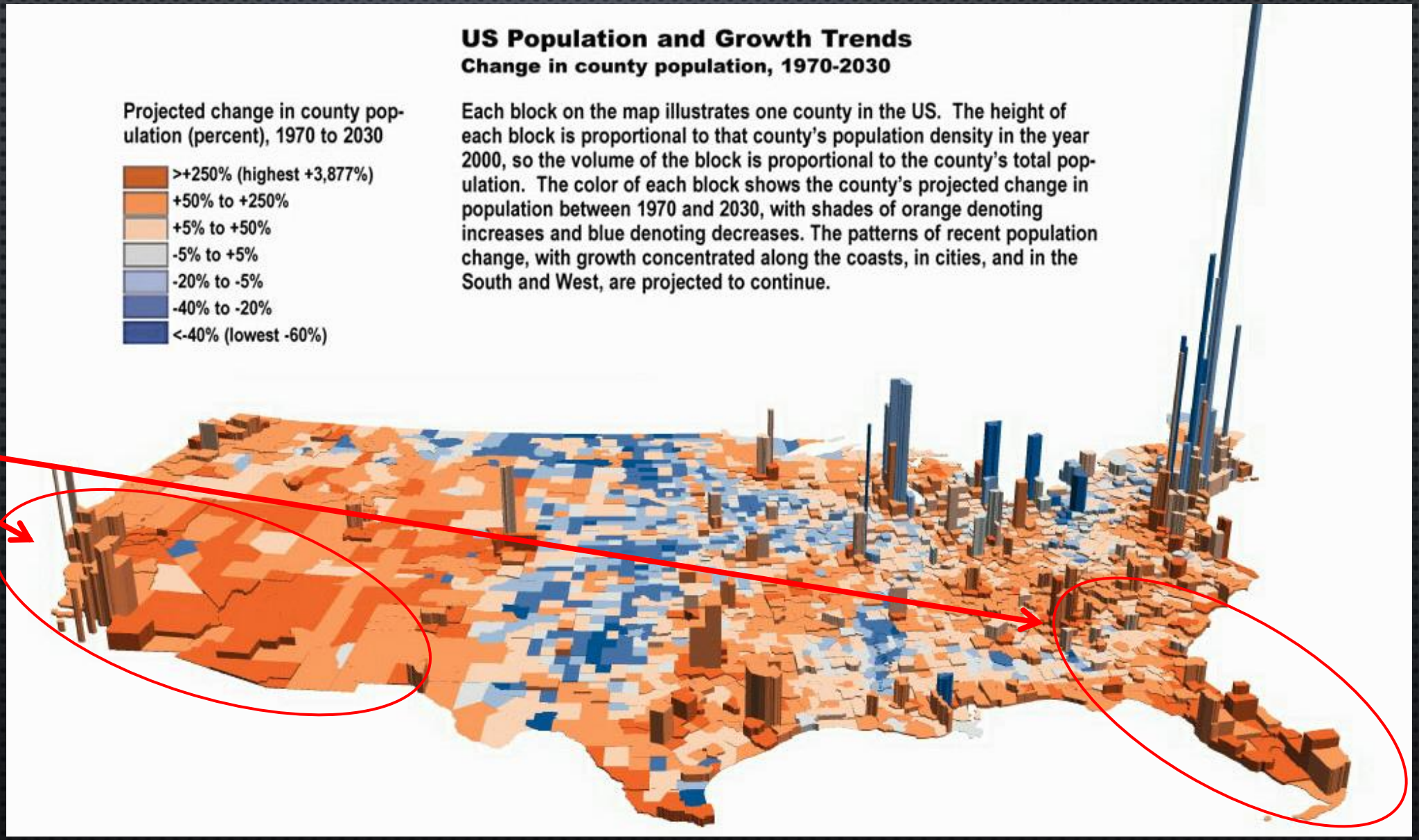
SECTION V:
THE WATER ENERGY NEXUS IN THE U.S.

Domestic Forms of Stress

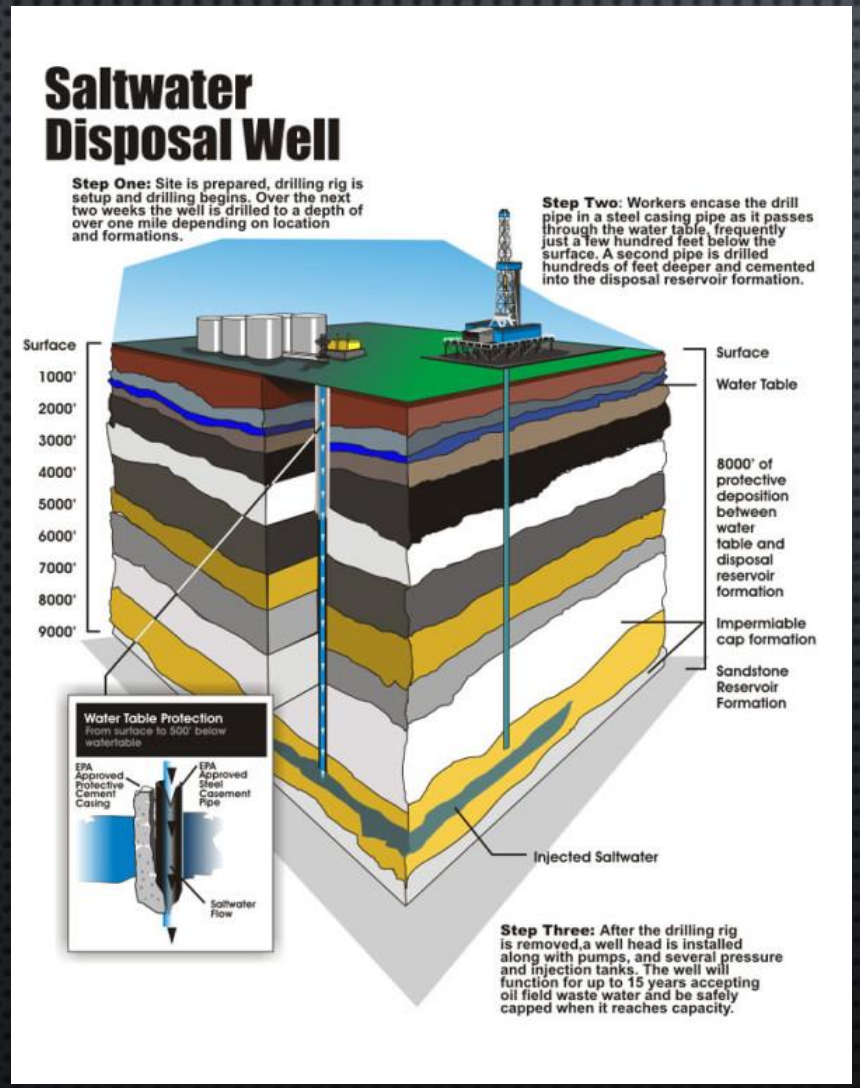
- 4 primary categories of stress on the water energy nexus in the U.S.
    1. Water Movement
        a) Think Flint, Michigan – over 3,000 other communities have it worse
        b) The aging water infrastructure – a $1 trillion problem
    2. Secure access to energy & water
        a) Thing Standing Rock Prostests
        b) Sardis Lake here in Oklahoma
    3. Water availability
    4. Treatment & Disposal of waste waters from energy production

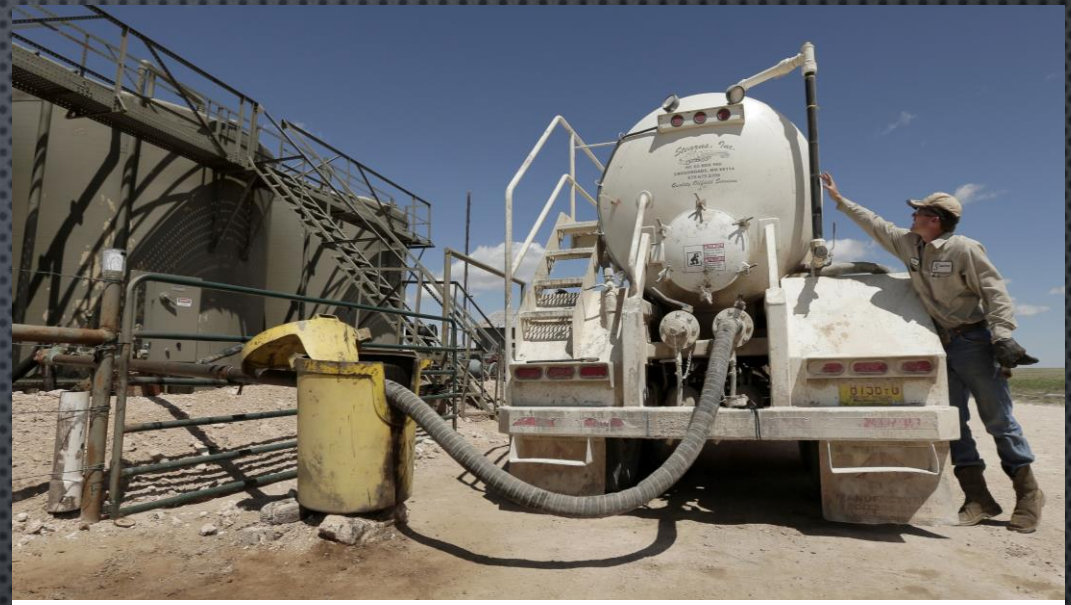
WATER AVAILABILITY IN THE U.S.

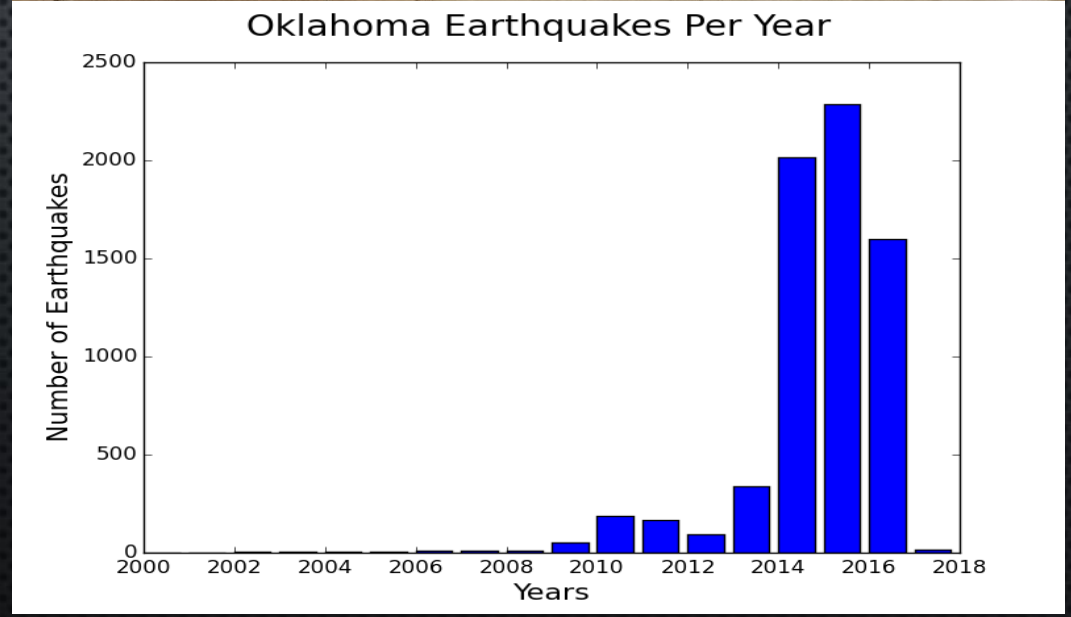
Areas of highest population growth are also the hottest, require the most electricity, and have the poorest sources of fresh water



WASTE WATER DISPOSAL



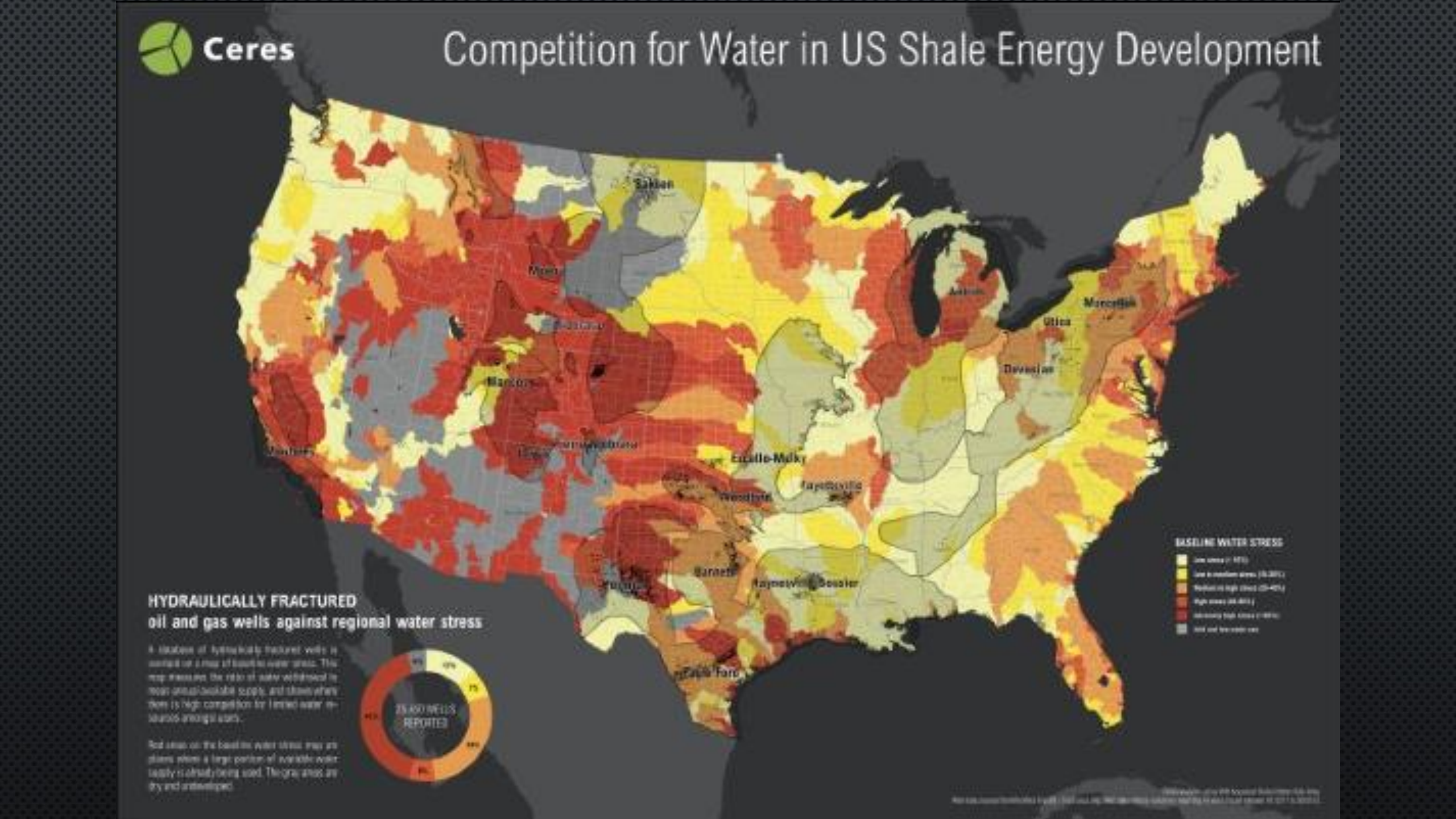




SECTION VI:
THE NEXUS' IMPACT ON OKLAHOMA

Ceres

Competition for Water in US Shale Energy Development



HYDRAULICALLY FRACTURED
oil and gas wells against regional water stress

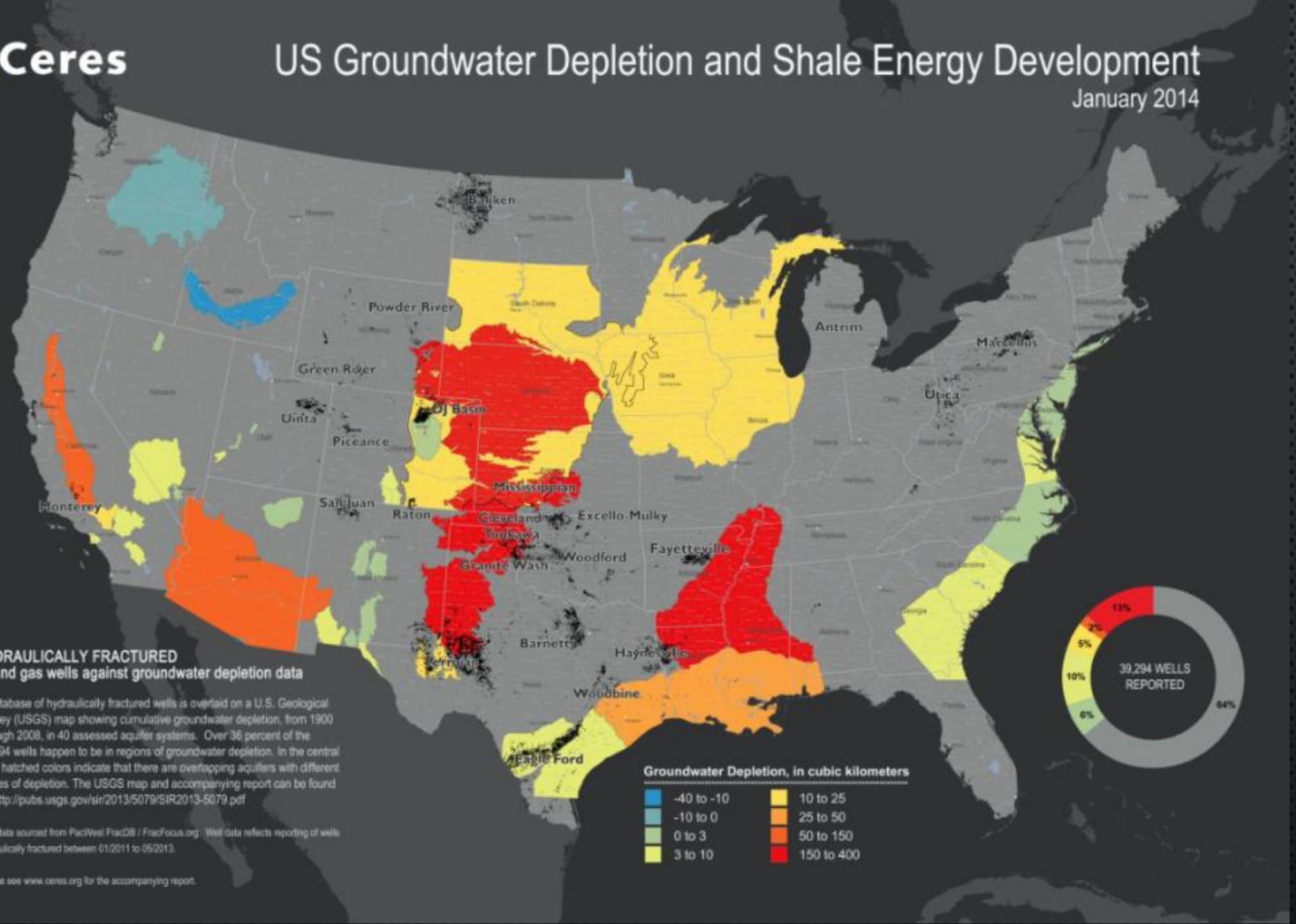
A database of hydraulically fractured wells is overlaid on a map of baseline water stress. This map measures the ratio of water withdrawal to mean annual available supply, and shows where there is high competition for limited water resources among users.

Red areas on the baseline water stress map are places where a large portion of available water supply is already being used. The gray areas are dry and undeveloped.

Ceres

US Groundwater Depletion and Shale Energy Development

January 2014



HYDRAULICALLY FRACTURED
oil and gas wells against groundwater depletion data

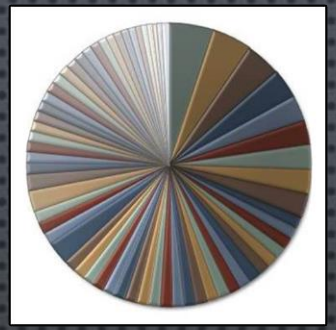
A database of hydraulically fractured wells is overlaid on a U.S. Geological Survey (USGS) map showing cumulative groundwater depletion, from 1900 through 2008, in 40 assessed aquifer systems. Over 36 percent of the 39,294 wells happen to be in regions of groundwater depletion. In the central U.S. hatched colors indicate that there are overlapping aquifers with different values of depletion. The USGS map and accompanying report can be found at http://pubs.usgs.gov/sir/2013/5079/SIR2013-5079.pdf

Well data sourced from PacWest FracDB / FracFocus.org. Well data reflects reporting of wells hydraulically fractured between 01/2011 to 05/2013.

Please see www.ceres.org for the accompanying report.

THESE AREN'T YOUR FATHER'S FRACK JOBS

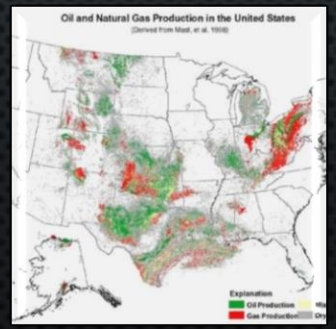
4.75 million gallons
(standard frac job in Oklahoma)



1%
(Estimate of oil-related wastewater recycled in Oklahoma)

2% vs. 30%
(Statewide vs. local demand of freshwater from fracking)

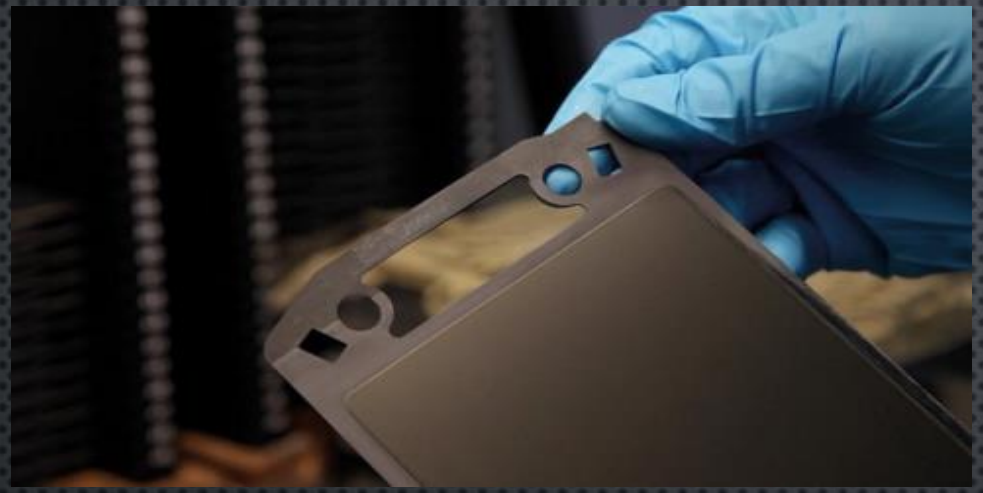
70%
(amount of water in frac job lost downhole)

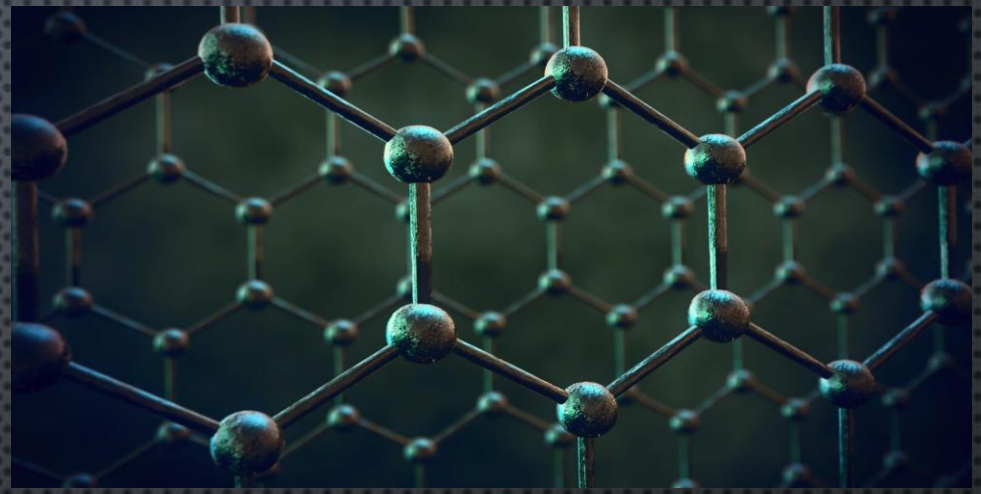


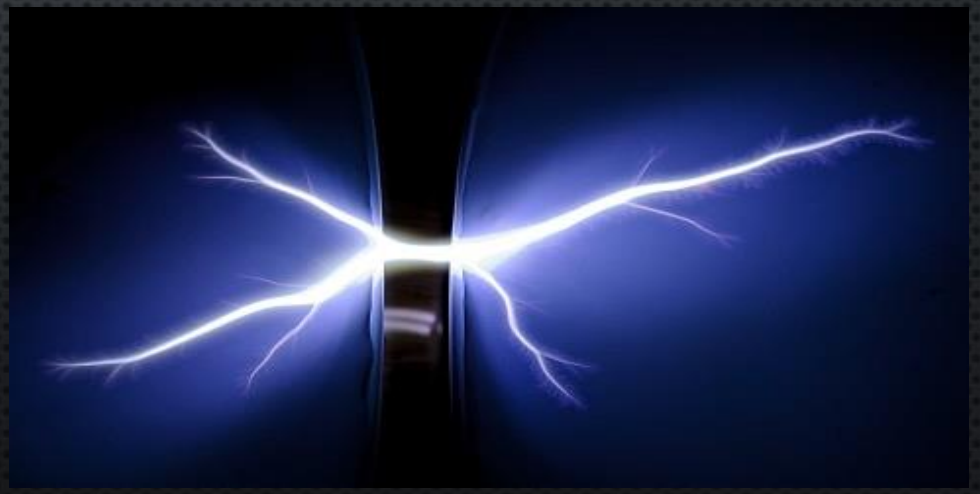
128%
(increase in freshwater demand since 2008)

SECTION VII: SOLUTIONS

THERE ARE PROMISING TECHNOLOGY IS ON THE HORIZON

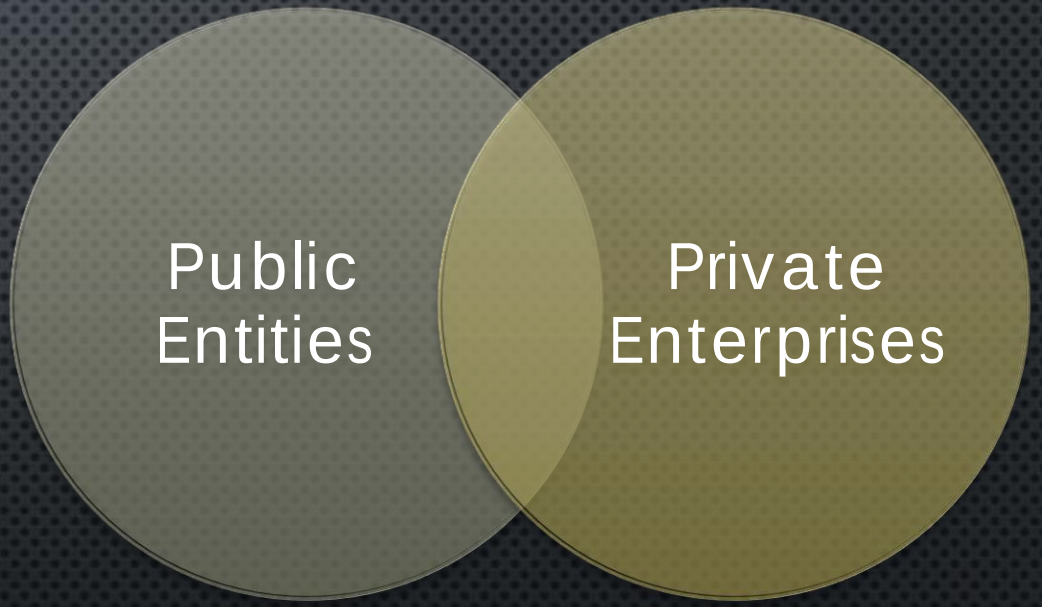






Only Collaboration Will Provide the Long-Term Solution

- Public-Private Partnerships
- Increases in state- and federal-grants
- Regulatory changes to accelerate technology adoption
- Policy initiatives that motivate changes in behavior
- Better Public awareness



Summary

- Understanding the Water-Energy Nexus is Vital
- Identifying the Key Stress Points Frames the Public Debate
- Addressing the Underlying Issues Causing the Stress Points is a Must for Policy Makers
- Under Current Dynamics, the Water-Energy Nexus Will Fracture
- While Solutions Should be Market-Based, Any Course Must Put Water First
- Fortunately, We Have Answers

Questions?

For a transcript of the speech or a copy of the slides:

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morford@thebisongrp.com