

22 July 2014

THE NEXUS OF ENERGY & WATER

ENERGY SYSTEMS INTEGRATION 101

National Renewable Energy Laboratory

PETER THOMSON

22 July 2014

INTRODUCTION

DRIVING FORCES

- Human History to 1800s to reach 1 Billion
- 7 Billion+ today
- Add 1 Billion people every 10-11 years

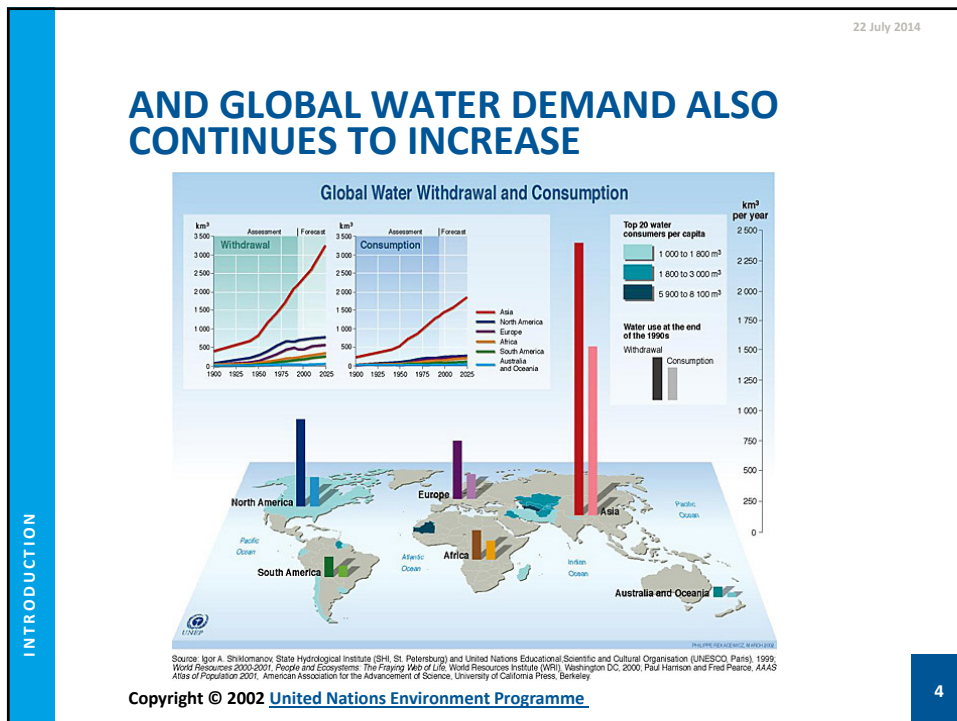
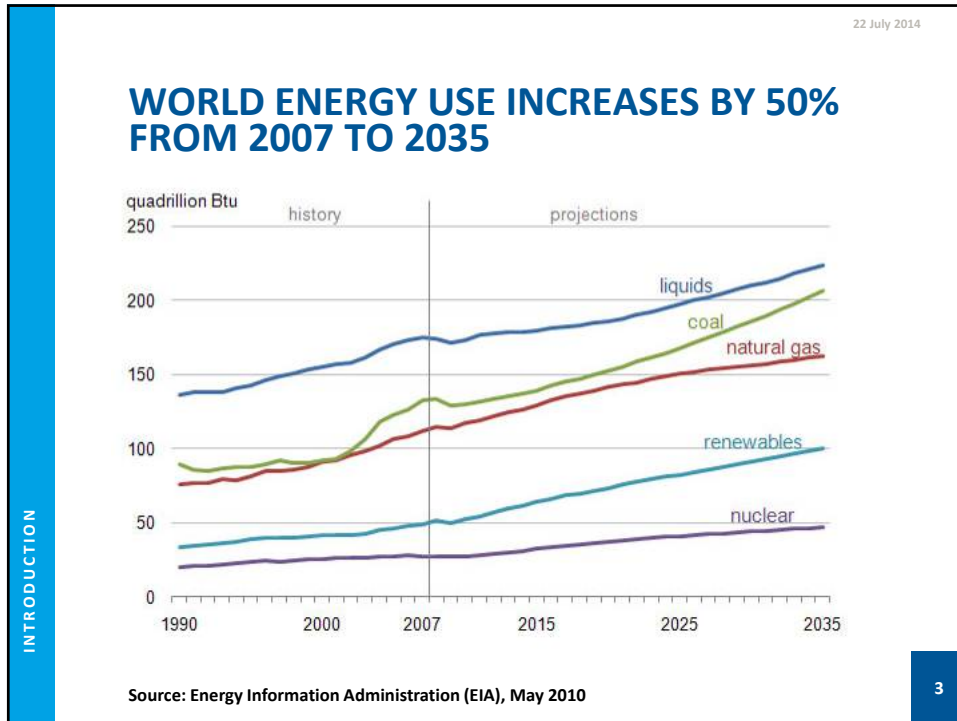
Population Growth, Urbanization

Economic Development

Improved Standard of Living in Emerging Countries

Climate Change

2

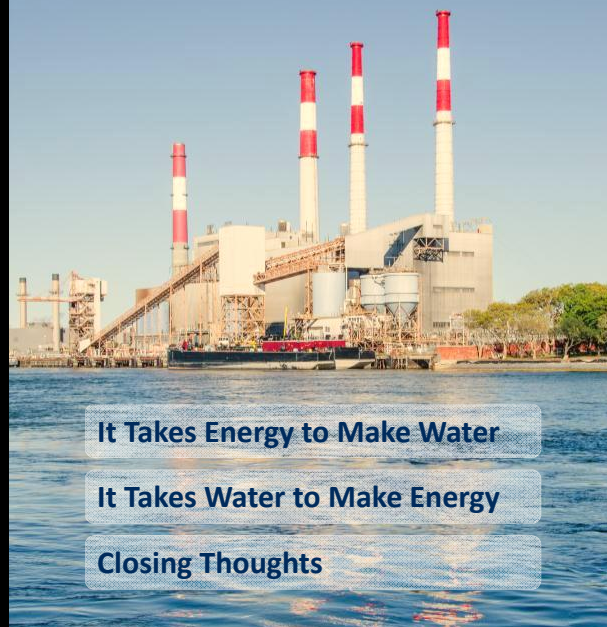


WHAT KEEPS WATER & ENERGY INDUSTRY LEADERS UP AT NIGHT?

- ✓ Economic pressure
- ✓ Public pressure
- ✓ Political / policy pressure
- ✓ Sustainability / climate change pressure
- ✓ Pressure to innovate



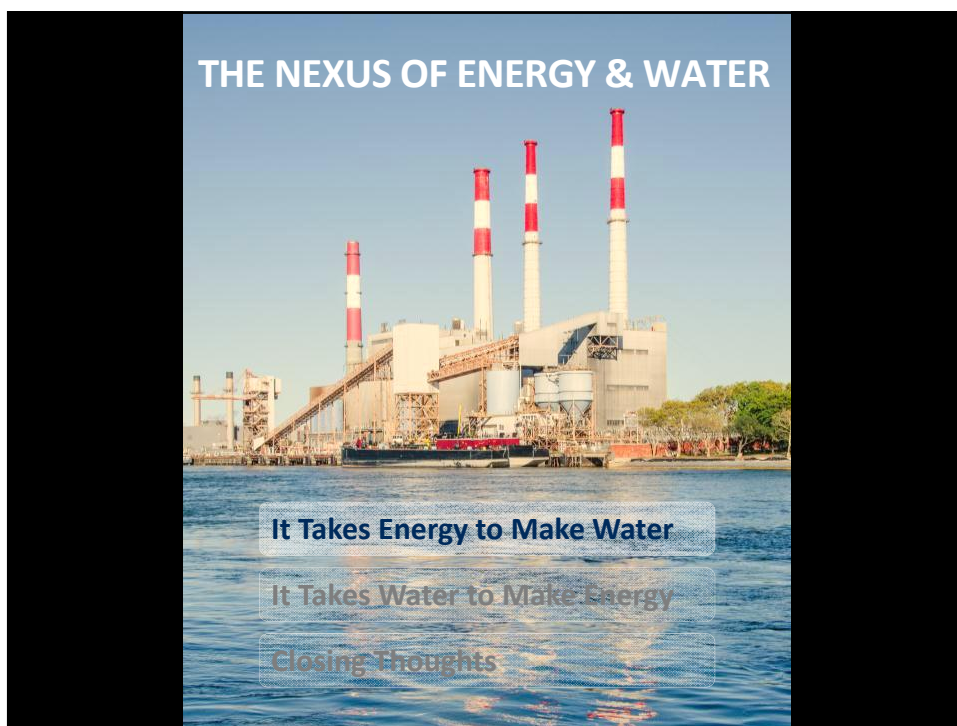
THE NEXUS OF ENERGY & WATER



It Takes Energy to Make Water

It Takes Water to Make Energy

Closing Thoughts



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CHANGING PERCEPTIONS OF THREE KEY STAKEHOLDERS

IT TAKES ENERGY TO MAKE WATER

- Consumers and Customers
- Policy Makers and Politicians
- Industry Owners and Leaders

8

IT TAKES ENERGY TO MAKE WATER

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CHANGING PERCEPTIONS OF THREE KEY STAKEHOLDERS

Consumers and Customers

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9

IT TAKES ENERGY TO MAKE WATER

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IF YOU WANT TO SAVE WATER, TURN OFF THE LIGHTS!



8oz of water = 30 min of 60W light bulb

10

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HOW MUCH WATER DOES A GOOGLE SEARCH USE?

Google

watercrunch.com

Google Search I'm Feeling Lucky

1/10 of a teaspoon of water

In 2013 Google averaged 5.9 billion searches per day.

11

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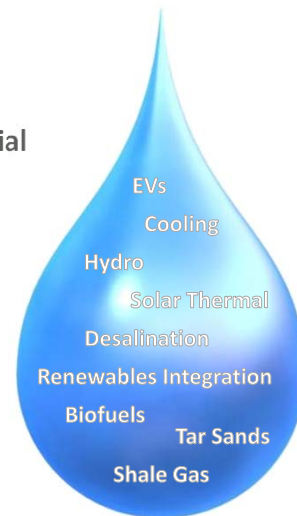
12

IT TAKES ENERGY TO MAKE WATER

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PUBLIC POLICY TO ENTERPRISE PERSPECTIVE

- Public policy clearly needs to address energy-water nexus
- Long-term viability of both essential energy and water services
- Many areas of mutual dependency
- Enterprise perspective
 - Supply planning decisions
 - Operational paradigms



13

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CHANGING PERCEPTIONS OF THREE KEY STAKEHOLDERS

Consumers
and Customers

Policy Makers
and Politicians


Industry Owners
and Leaders



14

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THE NEXUS OF WATER AND ENERGY



IT TAKES ENERGY TO MAKE WATER

15

This slide features a photograph of a dirt path that splits into two, leading into a dense forest with tall trees and green foliage. The path is covered in fallen leaves and dirt. The text 'THE NEXUS OF WATER AND ENERGY' is centered at the top. On the left, a vertical blue bar contains the text 'IT TAKES ENERGY TO MAKE WATER'. The date '22 July 2014' is in the top right corner, and the number '15' is in a blue box at the bottom right.

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WATER AND ENERGY ARE INTERTWINED



IT TAKES ENERGY TO MAKE WATER

16

This slide features a photograph of a cobblestone path that curves along a grassy mountain ridge. In the background, there are rolling hills and a valley under a cloudy sky. The text 'WATER AND ENERGY ARE INTERTWINED' is centered at the top. On the left, a vertical blue bar contains the text 'IT TAKES ENERGY TO MAKE WATER'. The date '22 July 2014' is in the top right corner, and the number '16' is in a blue box at the bottom right.

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ENERGY USE AND COSTS IN WATER VALUE CHAIN

- Second largest operating cost, after labor
- Current financial distress for water / wastewater utilities
- Spectrum of measures to shrink energy costs, increase energy (and water) efficiency
 - Leakage
 - Energy management data
 - Equipment choice
 - Process optimization
 - Peak demand shifting
 - Micro-hydro
 - Digester gas capture / use
 - Biosolids



Energy consumption for the water and wastewater sectors is expected to increase by 33 percent in the next 20 years because of global population growth.

(Source: [Watergy](#))

17

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DIGESTER GAS GOING TO WASTE

20 BILLION SCF

enough for 200,000 homes



18

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ENERGY-EFFICIENT OPTIONS FOR WATER



19

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CONSIDER THE WHOLE

Think globally

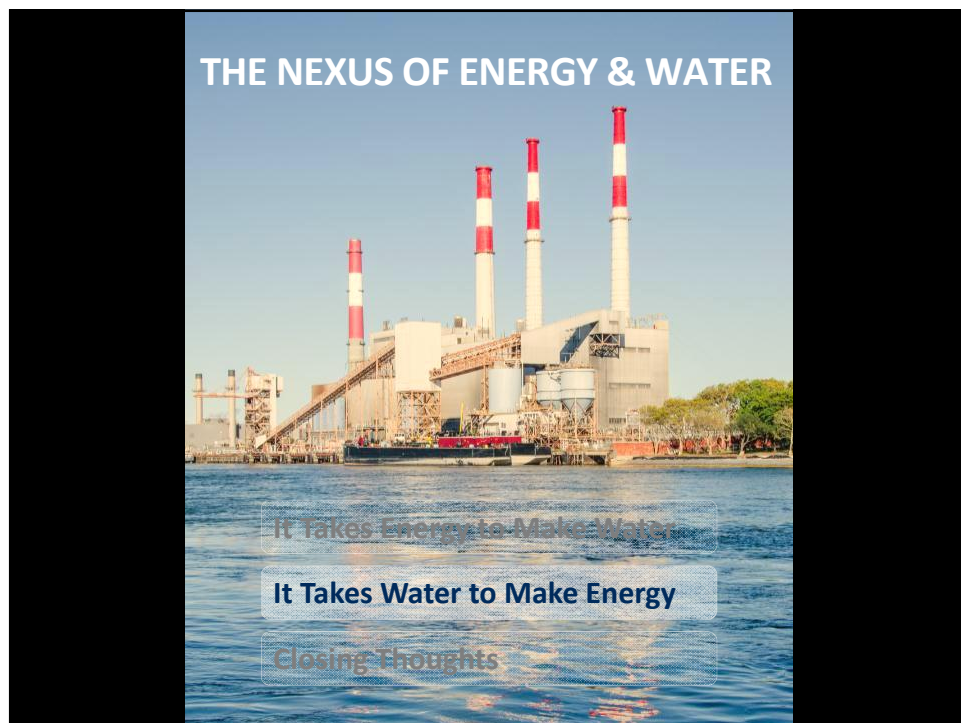
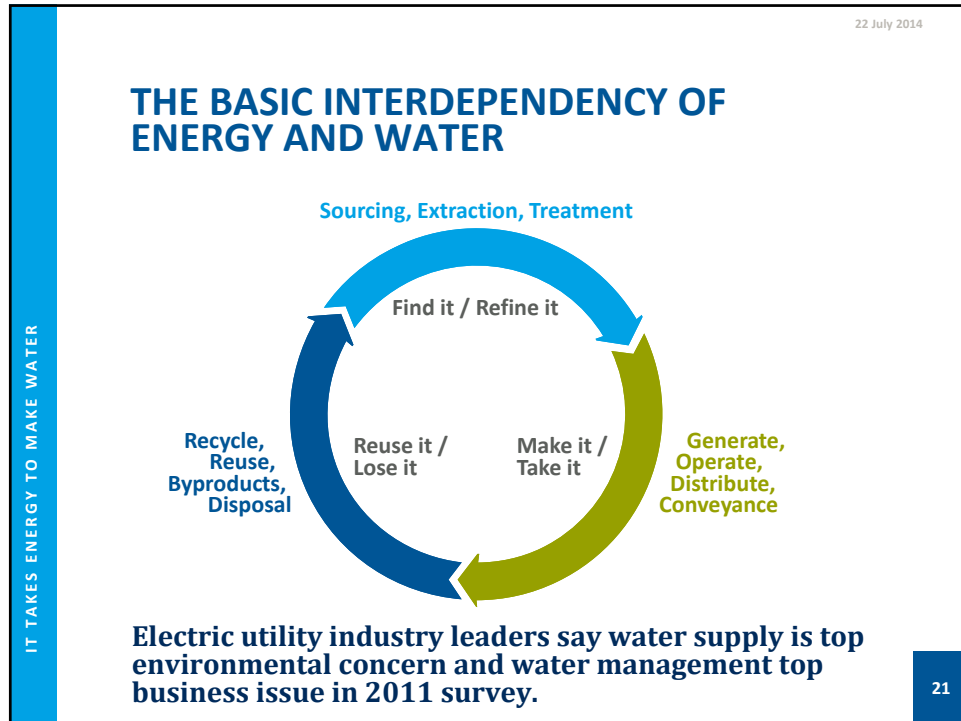
Integrate across
multiple
sectors

Avoid silo-ed
thinking



The developed world often takes a constant supply of potable water for granted, unaware of the growing challenges facing the world's water supply.

20



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IT TAKES WATER TO MAKE ENERGY

THE ENERGY PUZZLE

Solutions in all these areas will be required

23

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IT TAKES WATER TO MAKE ENERGY

ENERGY AND WATER ARE INTENSELY INTERDEPENDENT

Water used to produce household electricity exceeds direct household water use

Category	Gallons/person/day
For food (indirect)	~520
For electricity (indirect)	~480
For direct use	~100

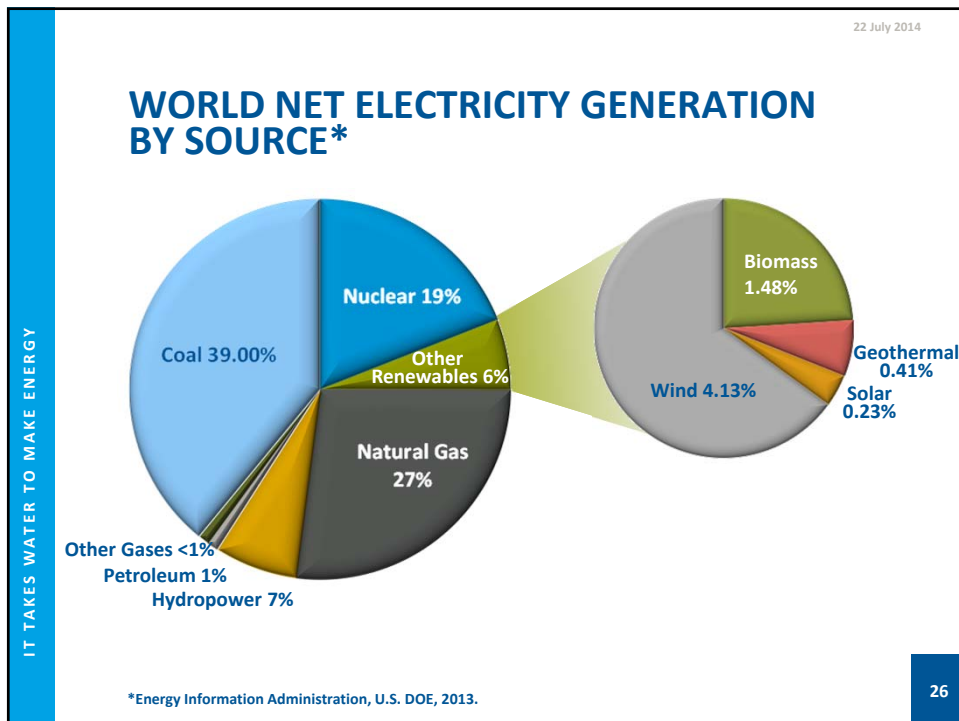
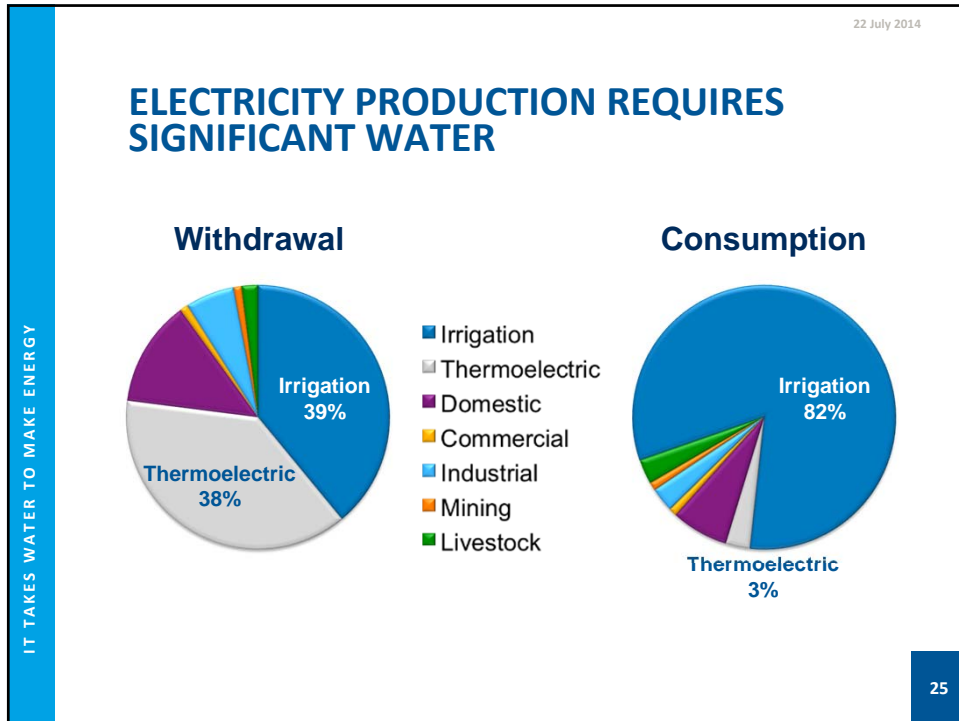
EAC Energy Analysis Office
Understanding Energy Issues
www.nrel.gov

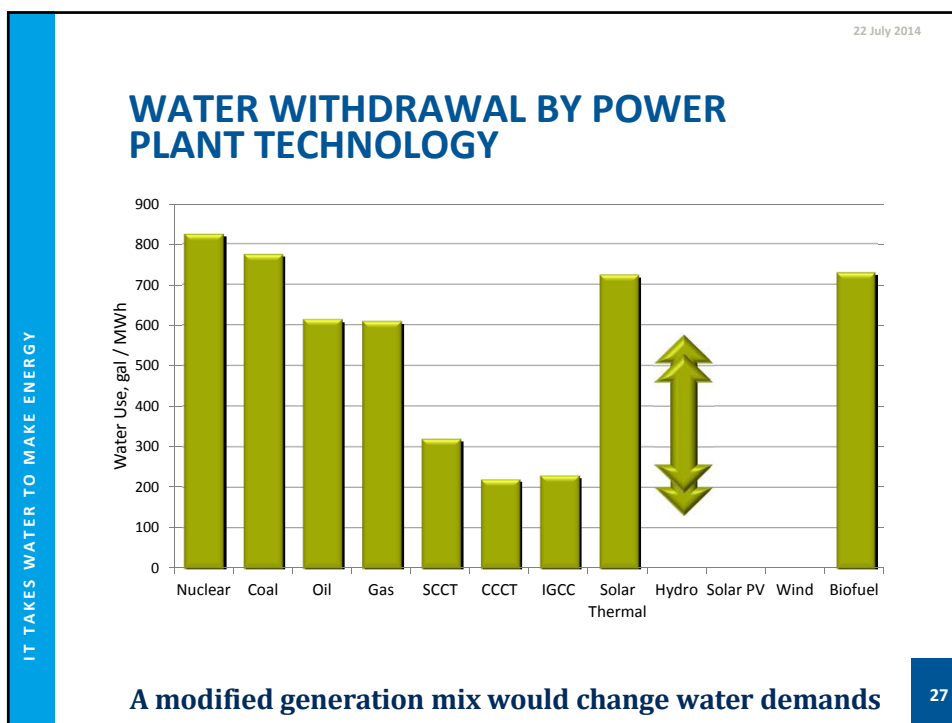
Energy required to deliver 1 m3 of treated water from:

Source	Energy (kWh/m ³)
Lake or River	0.37
Groundwater	0.48
Wastewater Treatment	0.62-0.87
Wastewater Reuse	1.0-2.5
Seawater	2.58-8.5

Source: Amended diagram based on Scientific American, October 2008.

24





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WATER USE AND COSTS IN ENERGY VALUE CHAIN

- Energy: Largest user of water
- Cooling and feedwater needs for thermal generation
- Current siting and permitting issues
- Likely regulatory trends on water usage
- Longer term regulatory and climate scenarios
- Risk reduction strategies
 - Lower gross generation
 - Cost / risk / flexibility in cooling
 - Alternative water supplies
- Smart Grid: Water utilities piggy-backing on customer connectivity

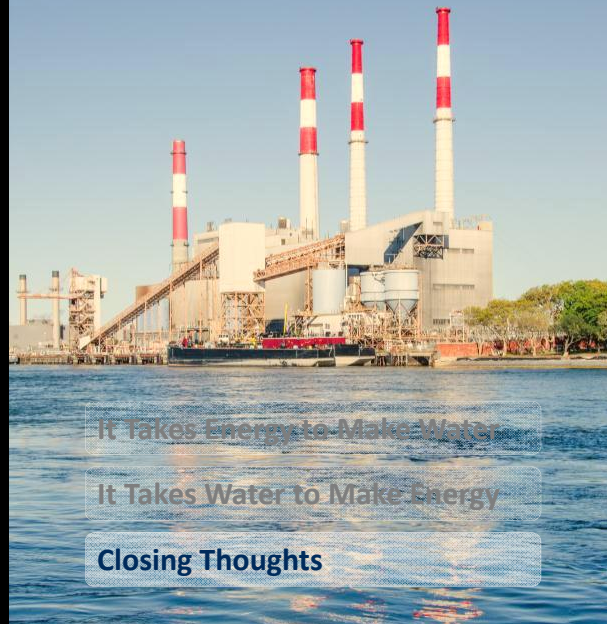
28

WATER SOLUTION STRATEGIES FOR ENERGY

- **Integrate energy and water resource planning / management**
 - Reduced generation / water demand
 - Diversified energy mix
- **Advanced technologies**
 - Dry / hybrid cooling
 - Increase thermal conversion efficiency
- **Alternative water supplies**
 - Recycle / recapture water within plant
 - Gray / reclaimed / brackish water
 - Sub-stratum water
 - On-site desalination
- **Consumer behavior / DSM**



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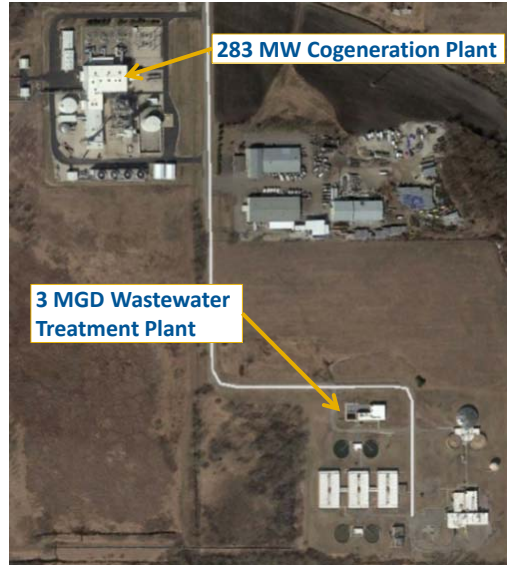
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Closing Thoughts

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A RECENT EXPERIENCE



- **Cogen Plant**
 - Uses 1 MGD of Water
 - Produces excess steam
- **WWTP**
 - Discharges 1.75 MGD
 - \$20 mil in upgrades
 - Would like to dry biosolids

31

THE NEXUS OF ENERGY & WATER

Energy and water interdependency
... *need to plan together*

Water getting scarcer
... *solutions are expensive*

Technologies available and evolving
... *change the mix, do more with less*

All stakeholders
... *a call to action*



IESI International Institute™
for Energy Systems
Integration

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QUESTIONS?

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 **BLACK & VEATCH**
Building a world of difference.