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American Council for an Energy-Efficient Economy

Watts in a Drop of Water: Savings Opportunities at the Water-Energy Nexus

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The American Council for an Energy-Efficient Economy (ACEEE)

- ACEEE is a 501(c)(3) nonprofit that acts as a catalyst to advance energy efficiency policies, programs, technologies, investments, & behaviors
- 50 staff; headquarters in Washington, D.C.
- Focus on end-use efficiency in industry, buildings, & transportation
- Other research in economic analysis; behavior; energy efficiency programs; & national, state, & local policy
- Funding:
  - Foundation Grants (52%)
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  - Contributions & Other (8%)

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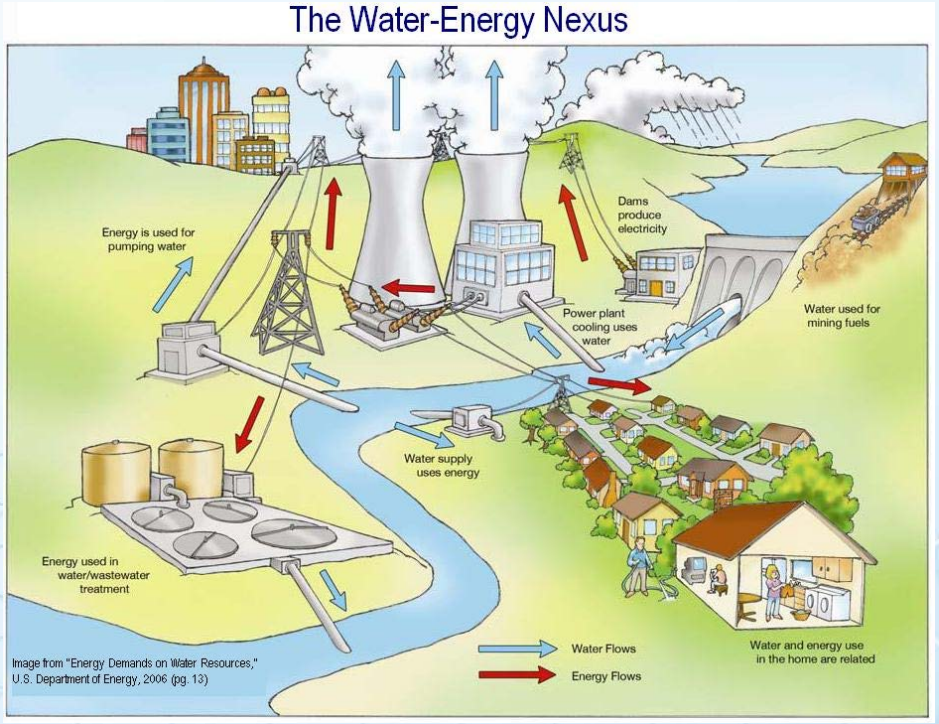
Outline

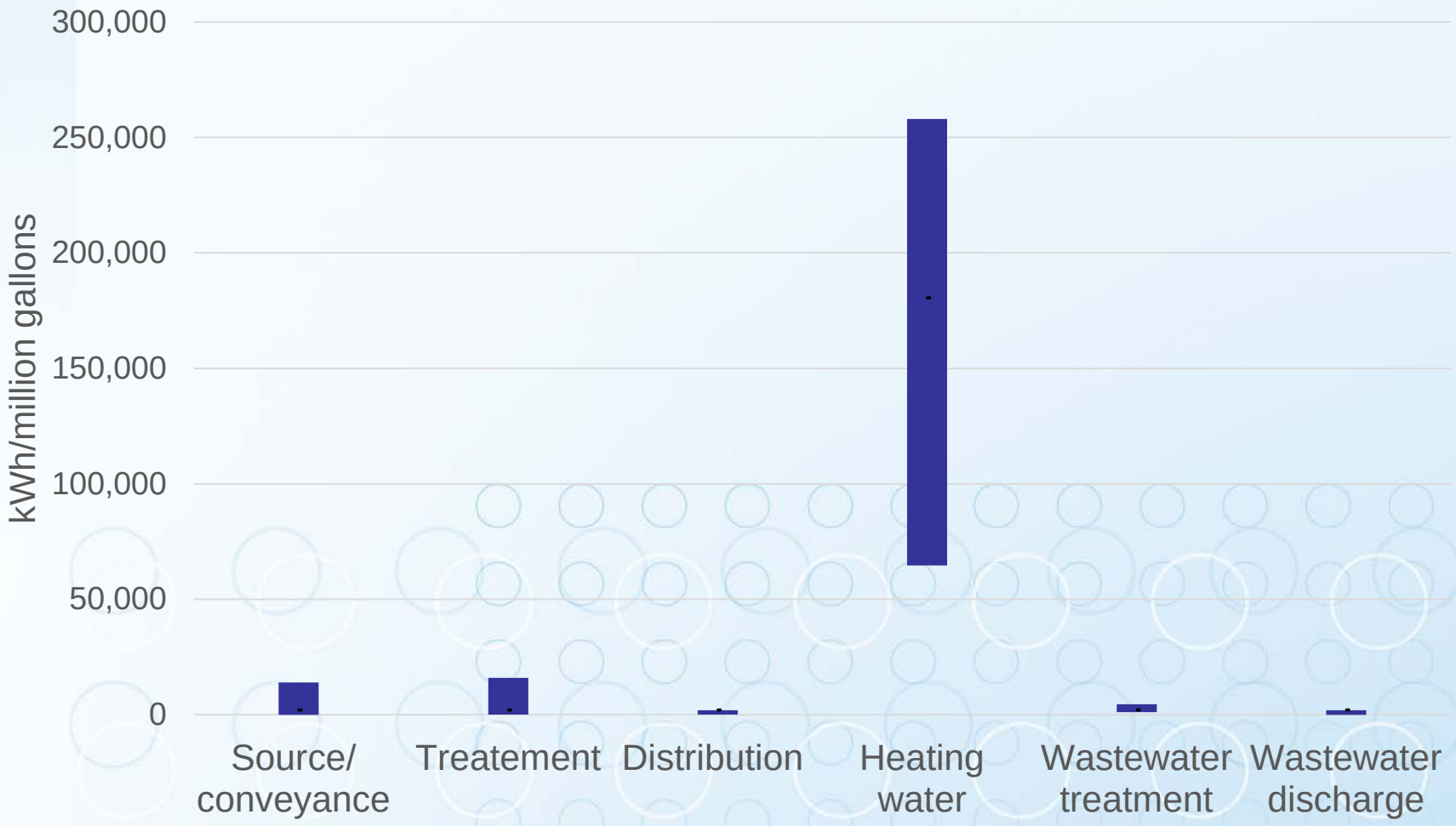
- What is the water-energy nexus
- Range of energy used in water services
- Energy saving opportunities
- Next steps

What is the energy-water nexus?

- Energy is needed to transport, treat, heat, cool, and recycle water.
- Water is needed in energy extraction, production, and processing.
- Saving water saves energy and saving energy saves water.



Energy intensity of water



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Source: ACEEE estimate using a variety of sources.

Energy intensity of water services

Source	State	Year	Water services (kWh/million gallons)		
			Source and Conveyance	Treatment	Distribution
CEC	CA	2005	0 - 14,000	100 - 16,000	100 - 1,200
EPRI	USA	2002	300 - 1,824		NA
ISAWWA	IL	2012	218 - 12,890 (range for all utility sizes) 1,560 - 2,912 (range of group means)		
	IN	2012	2,198-1,981 (range for 3 utilities)		

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Energy intensity of wastewater services

Source	State	Year	Wastewater collection (kWh/million gallons)	Wastewater treatment (kWh/million gallons)				Wastewater discharge (kWh/million gallons)
CEC	CA	2005	1,100 - 4,600					NA
EPRI	USA	2002	NA	Trickling Filter	Activated Sludge	Advanced Treatment	Advanced treatment with nitrification	NA
			NA	1,811 – 673	2,236 - 1,028	2,596 - 1,188	2,951 – 1,558	NA
River Network	USA	2009	700 - 4,600					0 - 400

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Water source matters

- Groundwater supply of water from public sources requires about 30% more electricity on a unit basis than supply from surface water.
- Groundwater requires energy to pump water to the surface:
  - Between 40 and 80 kWh required to lift one million gallons of water 10 feet.

	Ground water	Surface water
Domestic Withdrawals (million gallons per day)	8,468	17,168
Electricity consumption (kWh per million gallons)	1,824	1,406

Source: EPRI 2002

Utility size matters

- Over 150,000 public water supply systems in the United States.
- Approximately 23,000 privately operated treatment facilities.
- No water utility operates identically.
- Smaller utilities use more electricity per unit of water produced than do large utilities.

Utility Size	Mean (kWh/mgal)	Minimum (kWh/mgal)	Maximum (kWh/mgal)
Large	1,621	218	3,171
Medium	1,560	75	6,361
Small	2,912	110	12,890

Source: ISAWWA 2012

Energy in water in U.S.

Water Service	2005 (million kWh)
Energy in water source/conveyance	18,700
Energy in treatment	23,400
Energy in distribution	5,600
Wastewater Service	**2005 (million kWh)**
Energy in wastewater collection and treatment	11,000
Energy in wastewater discharge	1,500

Source: EPRI energy intensity data and USGS water withdrawal data

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Energy to heat water

Domestic	High	Typical	Low
Input temperature	47	57	67
Water heater temperature	140	125	120
Water heater efficiency (EF)			
Electric	0.88	0.92	2.0
Gas	0.52	0.59	0.80
Electric (kWh/million gallon)	258,010	180,450	64,697
Gas (Therm/million gallon)	14,898	9,601	5,519

Source: ACEEE analysis

River Network estimates for savings

Type of program	Reduction taken	Energy saving (million kWh)
Water service electricity use saving	1% of American homes replaced their older, inefficient toilets with WaterSense	38
Indoor residential electricity use saving	Hot water reduction of 20%	41,000
Water supply and treatment systems	5% reduction in water supply and treatment leaks, equal to 0.5% of total water supply.	313

Potential savings

	Hot water energy efficiency scenario (30% savings) (million kWh)	Cold water efficiency scenario (30% savings) (million kWh)
Water service electricity use		
Energy in water source/conveyance	2,300	1,200
Energy in treatment	2,800	1,500
Energy in distribution	700	400
Domestic electricity use		
Electricity to heat water consumed (typical water heating scenario)	102,000	-
Gas to heat water consumed (typical water heating scenario) (million Therm)	5,000	-
Wastewater service electricity use		
Energy in wastewater collection and treatment	1,400	700
Energy in wastewater discharge	200	100
Total electricity saved (million kWh)	**110,000***	**3,800**

Sources: ACEEE analysis, USGS 2005 (water withdrawals) and EPRI 2002 (energy intensity)

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EPA's Clean Power Plan

- EPA proposed rule regulates carbon emissions from existing power plants under section 111(d) of the *Clean Air Act*.
- EPA has set state targets using 4 building blocks:
  - Heat rate improvements
  - More natural gas
  - Re-generation
  - Energy efficiency
- States need to develop plans by ~June 2016 (2017 for multistate-plans).

Water and energy savings under 111(d)

- Energy efficiency can be used for compliance.
- Water programs should be considered in state plans because of their energy saving potential.
  - Saves energy at water and wastewater services facilities.
  - Saves energy required to heat water.

More work is needed

- Understanding variables that create the wide range of energy intensities for water services.
- Limited available data.
- Should be gathering and reporting energy use and water use at the water and wastewater utility level.
- Further work is required to estimate embedded water in energy.
- Developing a limited number of well documented factors could make crediting water energy savings easier under 111(d).

Questions?

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Exemplary Programs Report: www.aceee.org/research-report/e131

Energy and Water Utilities Working Together: www.aceee.org/research-report/e13h

Water-Energy Program Directory: www.aceee.org/w-e-programs

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