

This presentation premiered at WaterSmart Innovations

watersmartinnovations.com



The Energy Water Nexus of the End User

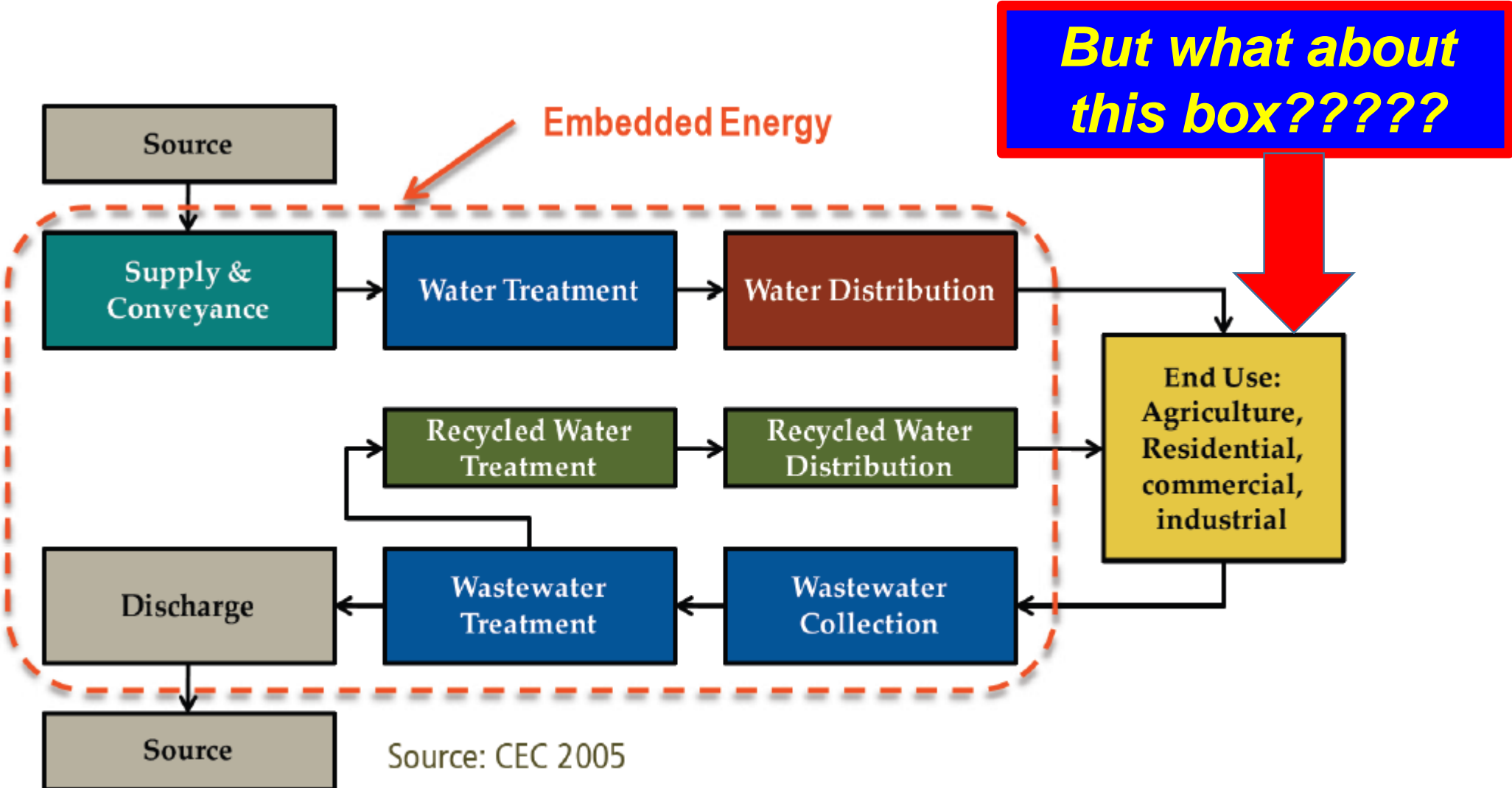


H.W (Bill) Hoffman P.E. – Frontier Associates

Steve Nadel – Executive Director – American Council for an Energy Efficient Economy

Presented at WaterSmart Innovations - 2015

The Classic Energy Water Nexus Diagram



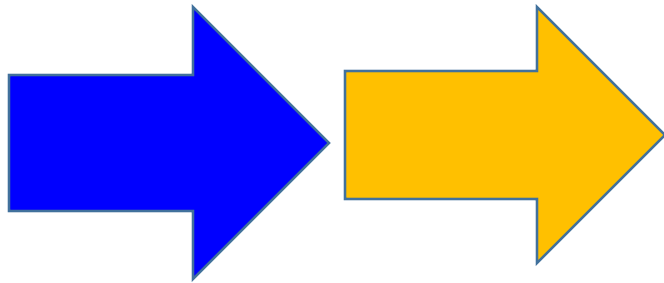
Our Topic

The energy water nexus of the end user

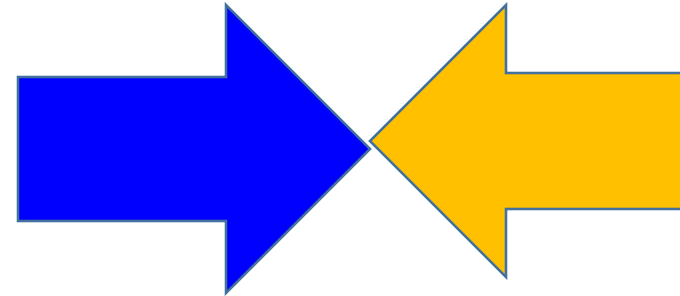
- Domestic Hot Water Use
- Boilers
- Food Steamers and Combination Ovens
- Ice Machines
- Commercial Laundry Equipment
- Dish Washers (domestic and commercial)
- Cooling Towers
- Sterilization
- Refrigeration Equipment
- Pressure Washers
- Etc.

Supporting and Conflicting Situations

**Most of the Time,
Saving Water Saves
Energy.**



***But Sometimes
they Conflict!***

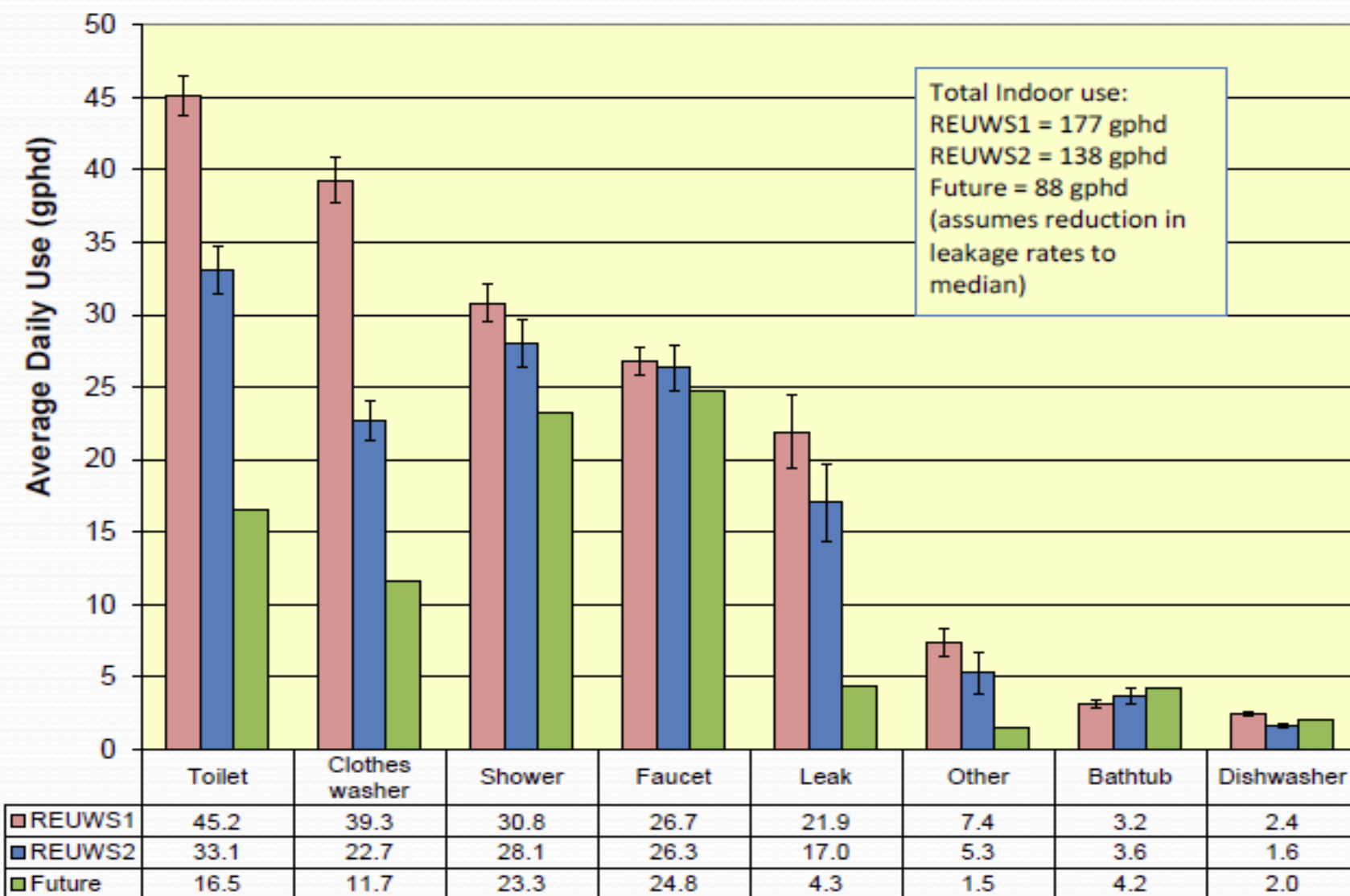


Three Examples Will Be Used

- **Domestic Hot Water Use**
- **Commercial Ice Machines**
- **Cooling Towers for Air Conditioning**

Domestic Hot Water Use

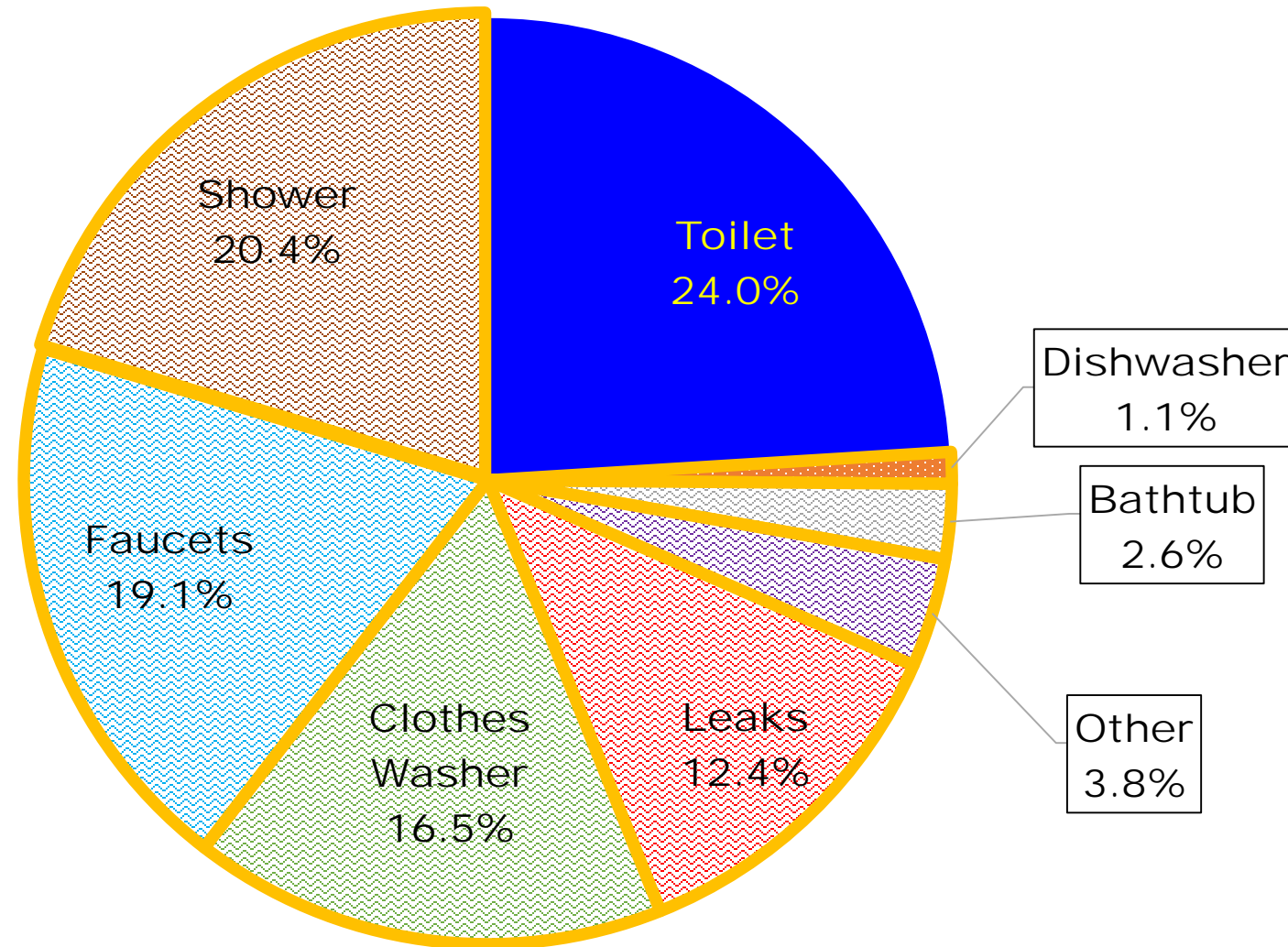
Potential end uses with leak control



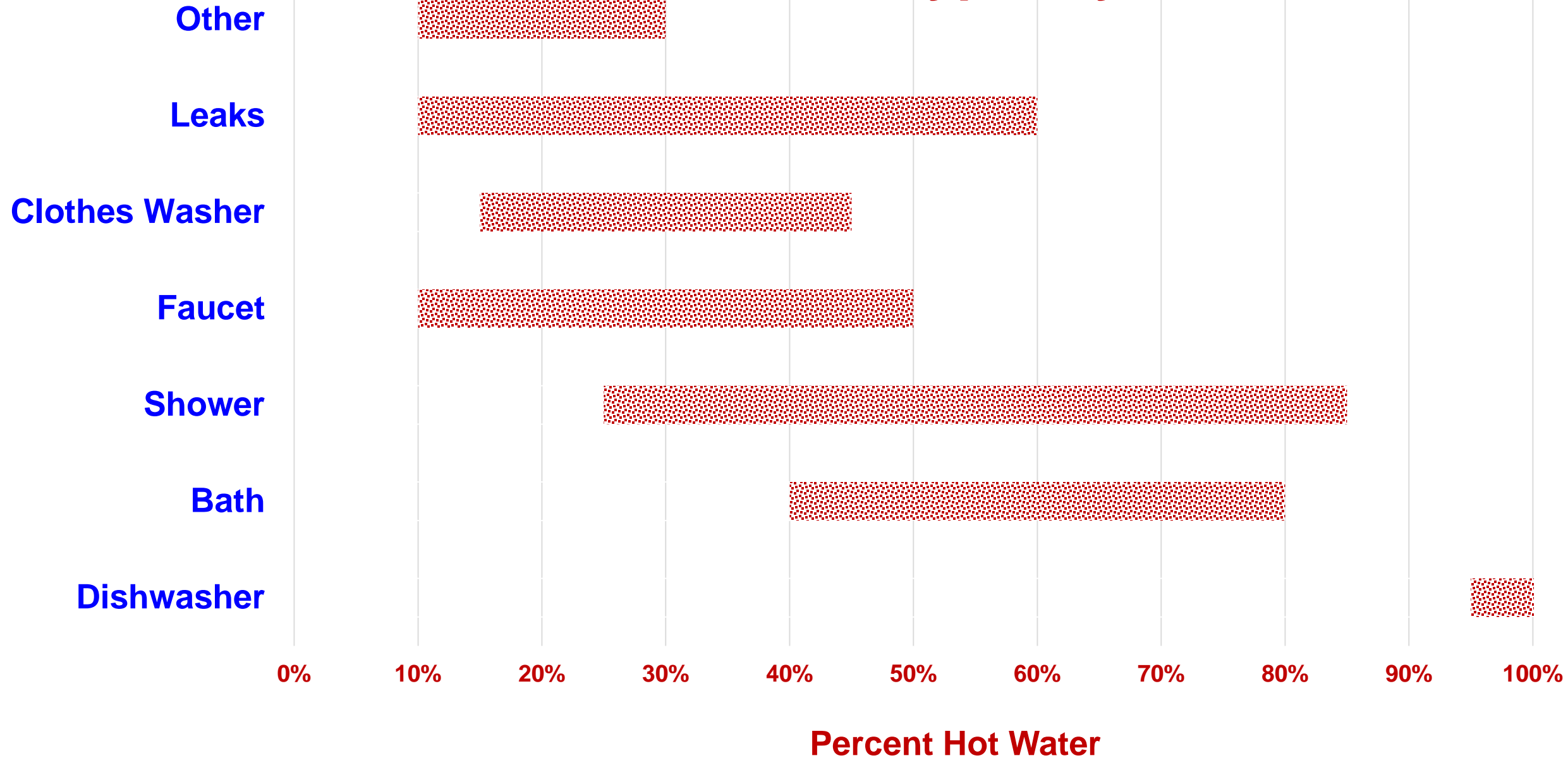
Residential Indoor Water Use 2014

AWWA

The orange border indicates potential hot water use

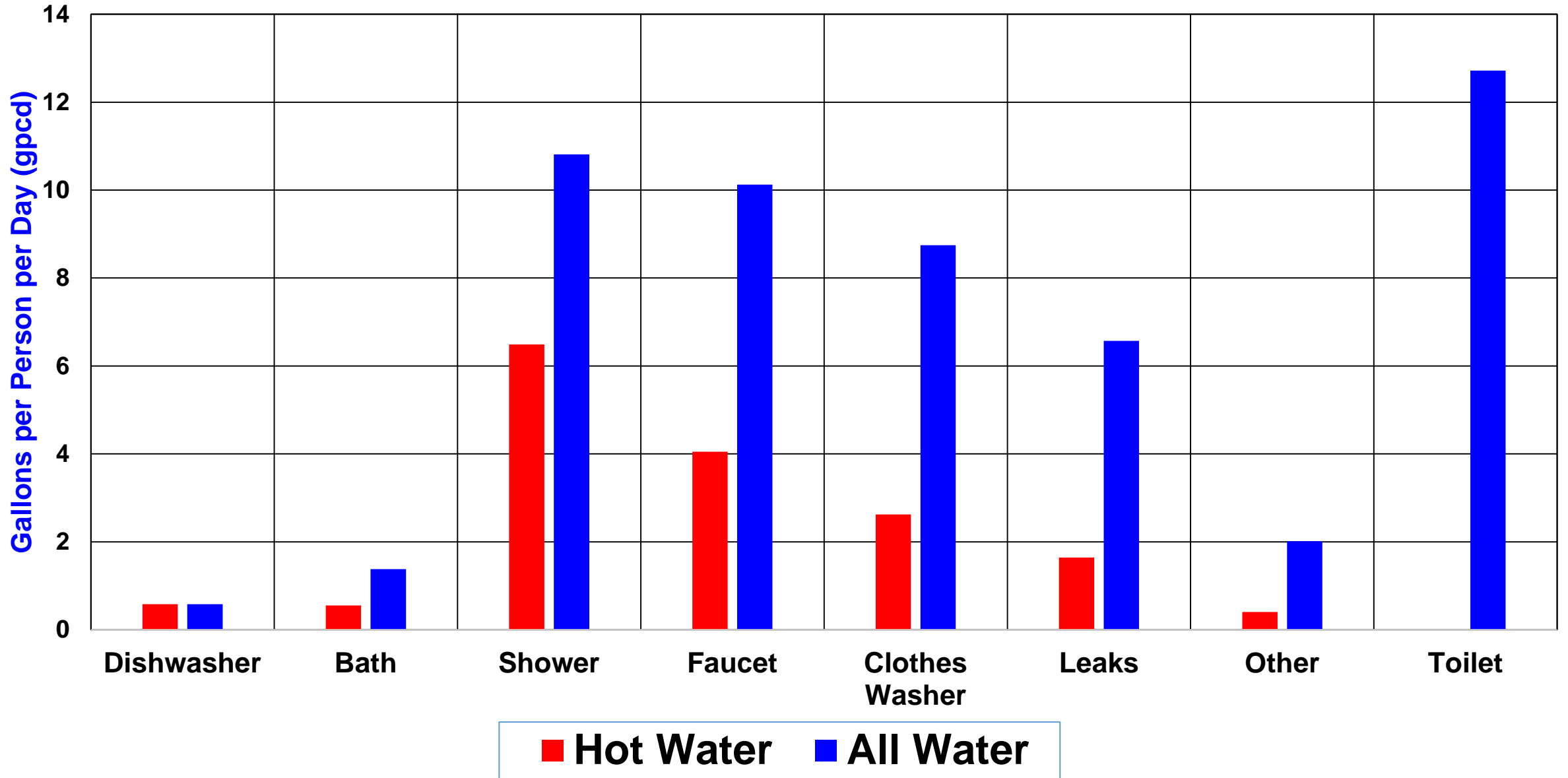


Percent of Home Water Use Typically Hot Water

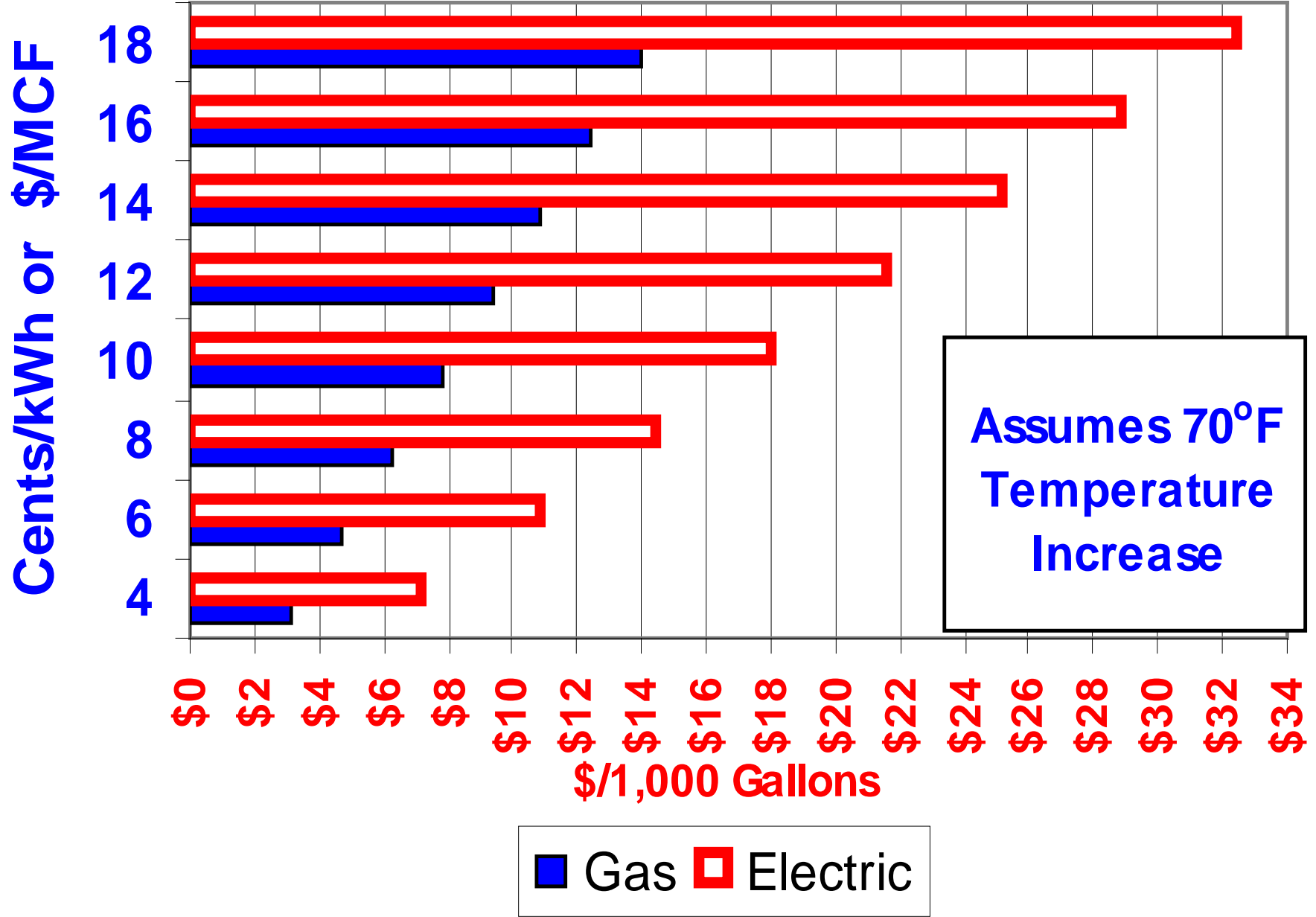


Per Capita Home Use

Total use = 53 gpcd, Hot water use = 16 -18 gpcd



Energy Costs for Heating Water



SUMMARY OF ENERGY INTENSITIES

Figure 2 summarizes the ranges of intensities in the water and wastewater services and energy embedded in heating water, using the electric water heater range shown in table 5. The numbers in the figure are what is reported in tables 1–6 and include the lowest and highest intensity reported by CEC, EPRI, ISAWWA, and the River Network.

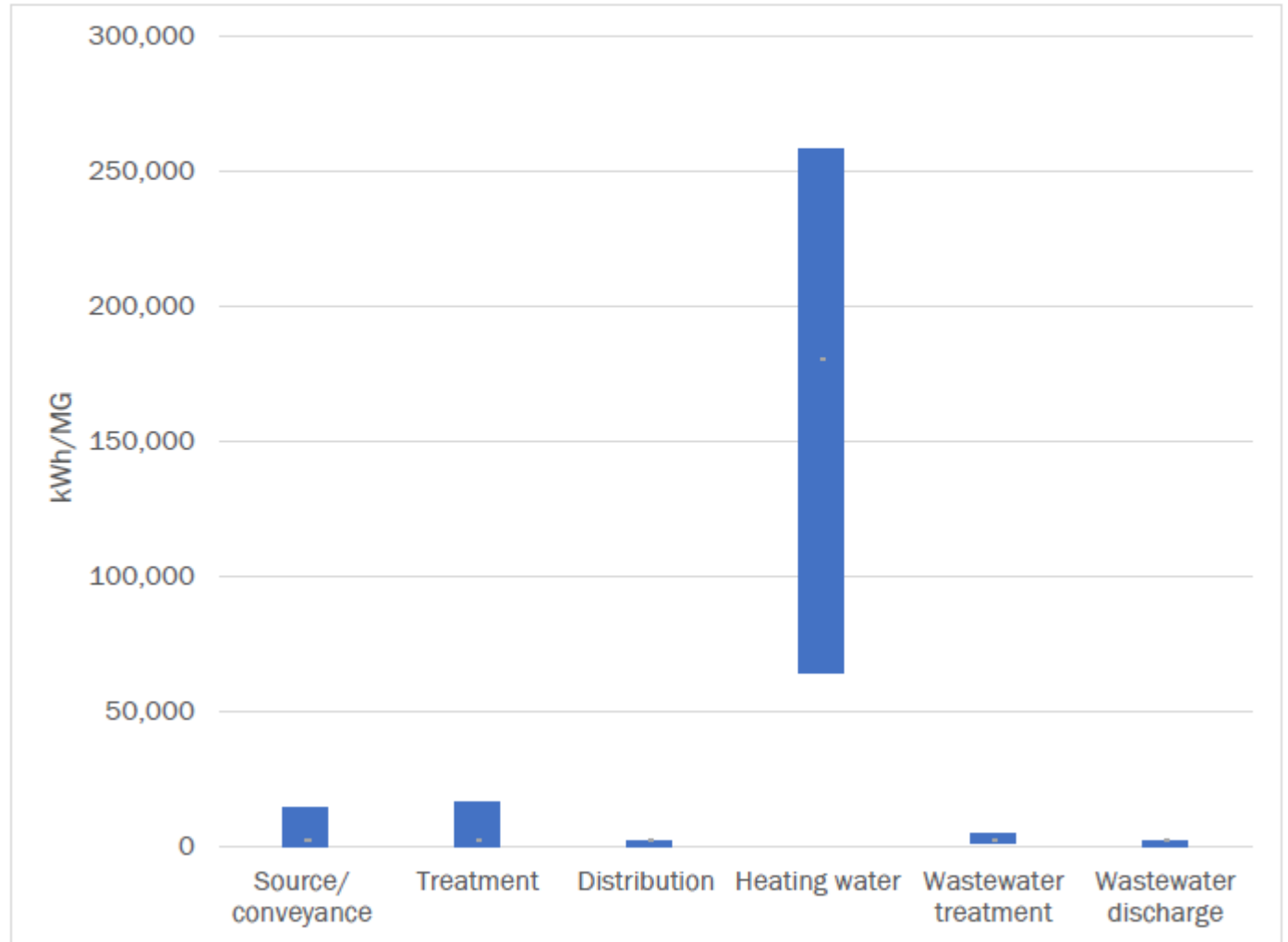


Figure 2. Ranges of energy intensity in water

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

Rachel Young
November 2014
An ACEEE White Paper

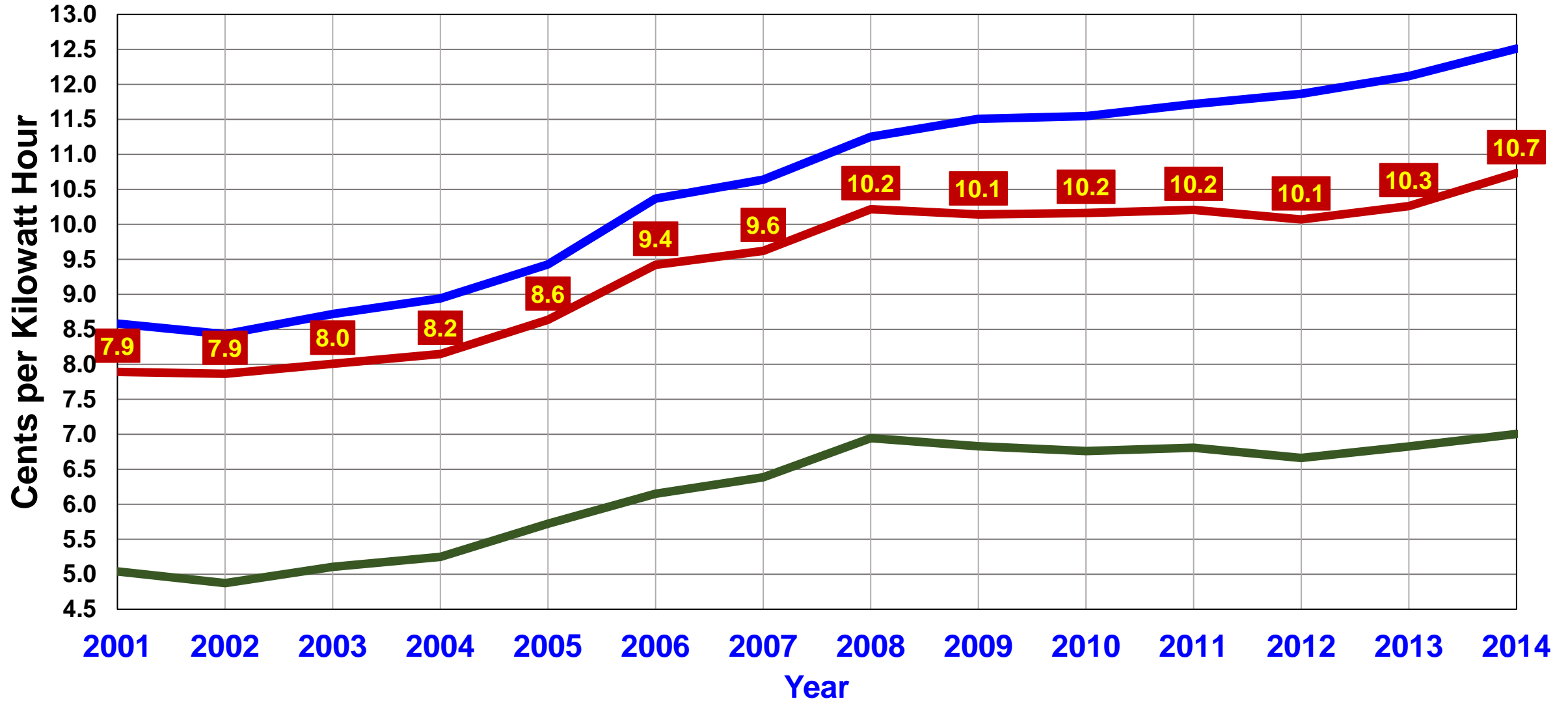
*Don't forget that
restaurants, hospitals,
hotels and all other
businesses use hot water
too!*

Setting the **\$**stage

United States Annual Average Electric Power Rates

Cents per Kilowatt Hour

<http://www.eia.gov/electricity/data/browser/#/topic/7?agg=2,0,1&geo=g&freq=M>

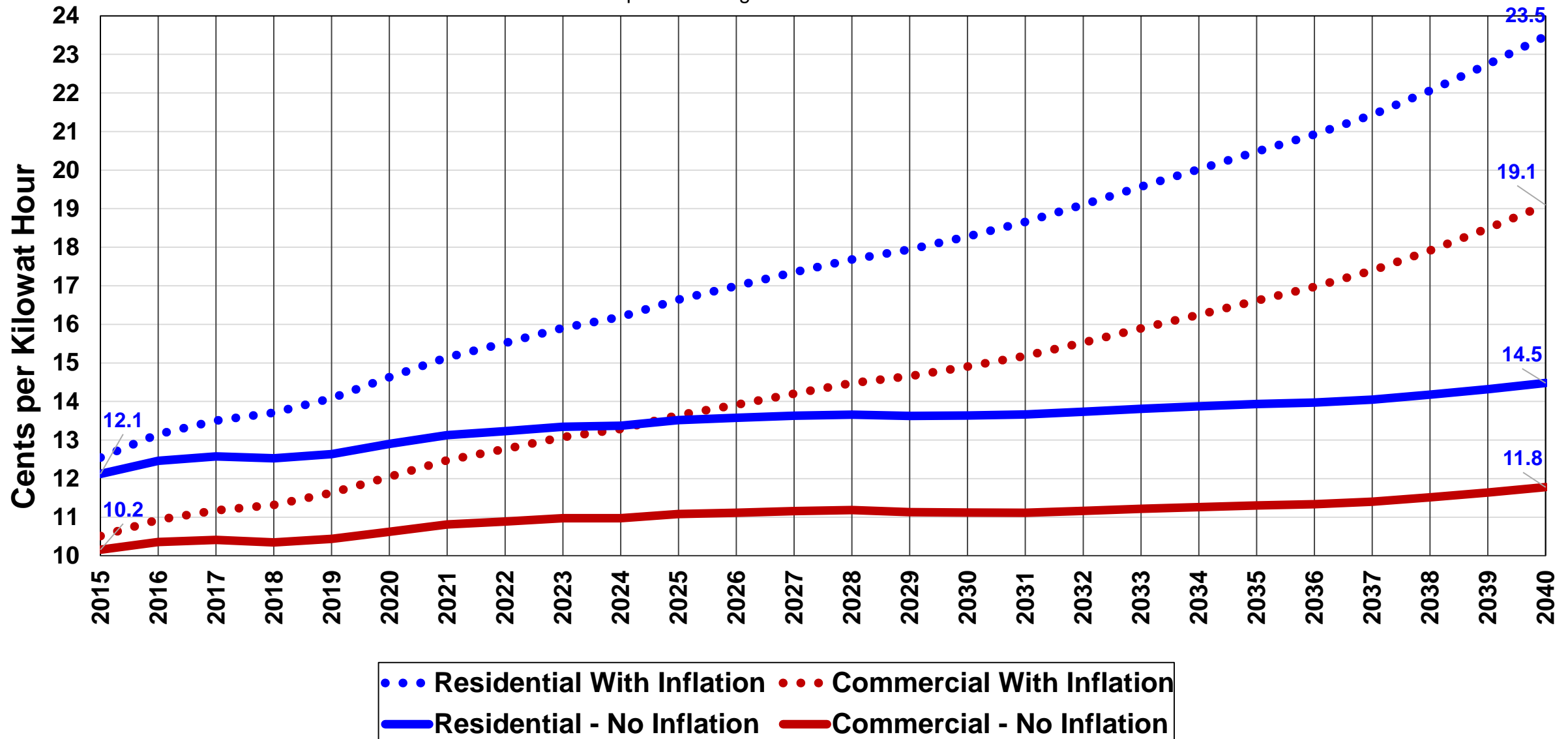


— Residential — Commercial — Industrial

Projected Price of Electricity for the Residential and Commercial Sectors in the USA 2015-2040

A 1.87 fold increase


Source: <http://www.eia.gov/beta/aeo/#/?id=8-AEO2015>



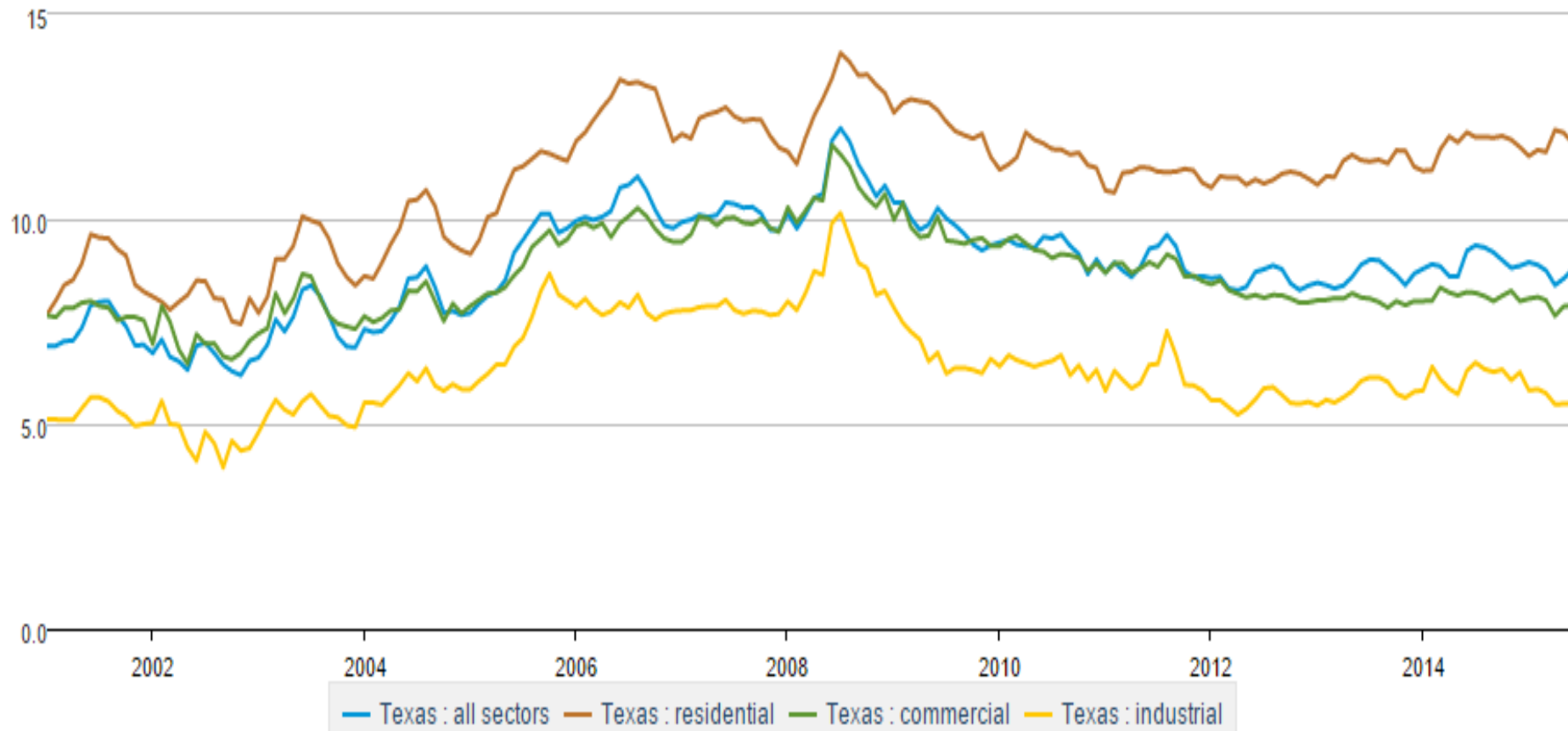
Average Electricity Prices in Texas

Average 2015 price 8.9 Cents/kWh

Average retail price of electricity, monthly

 DOWNLOAD

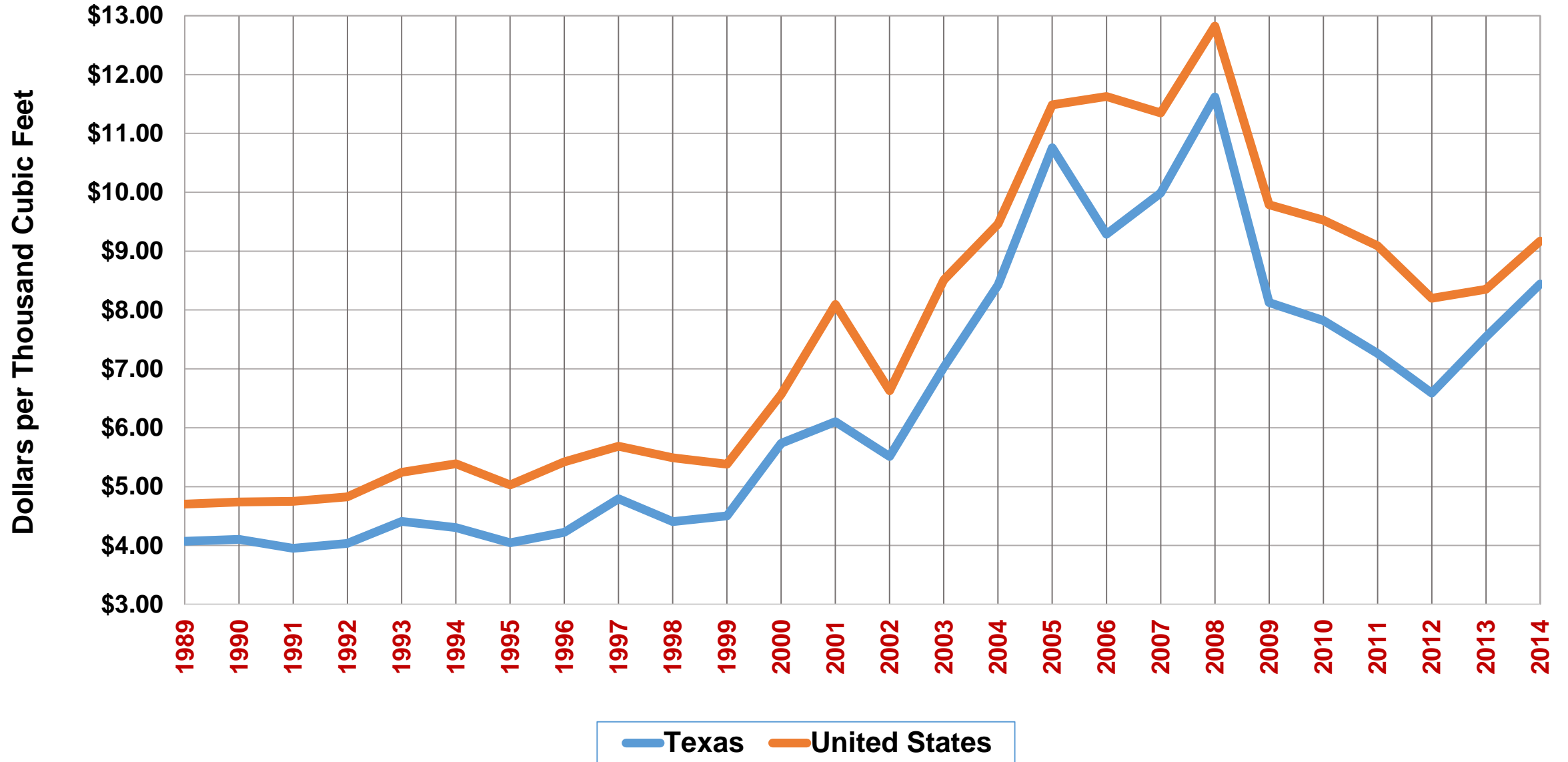
cents per kilowatthour



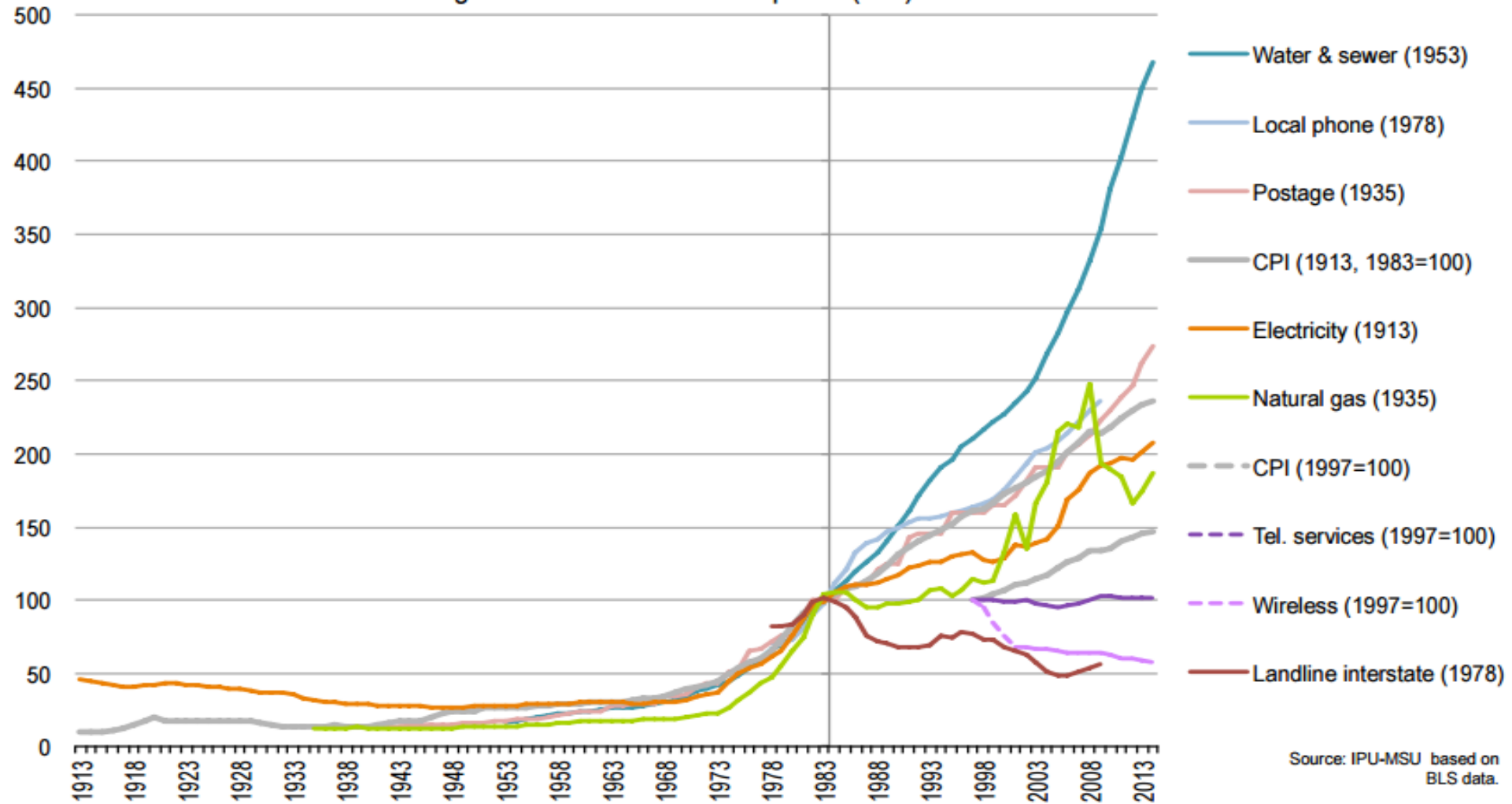
Data source: U.S. Energy Information Administration

Average Cost of Natural Gas For Commercial Establishments in Texas and United States 1989 through 2014

Sources: US Energy Information Administration - <http://www.eia.gov/dnav/ng/hist/n3020tx3m.htm> and <http://www.eia.gov/naturalgas/data.cfm>



Long-term trends in consumer prices (CPI) for utilities



Source: IPU-MSU based on BLS data.

Exhibit 1. Long-term trends in the Consumer Price Index (CPI) for utilities (1913-2014). The index is set to 100 for 1982-1984 except for telephone and wireless services, where the index is set to 100 for 1997. Year (*) indicates start of series.

Circle of Blue

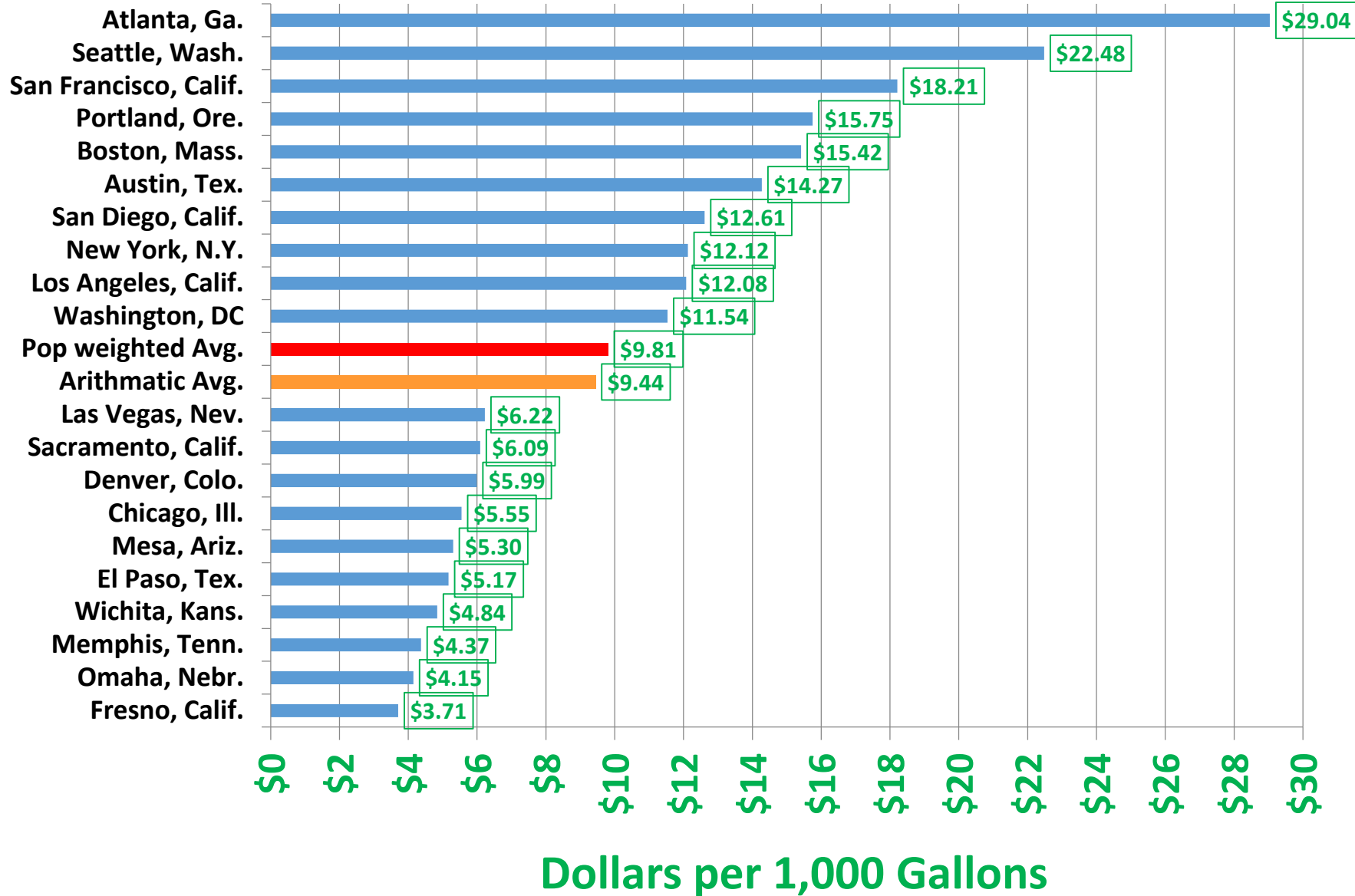
April, 2015

<http://www.circleofblue.org/waternews/2015/world/price-of-water-2015-up-6-percent-in-30-major-u-s-cities-41-percent-rise-since-2010/>

Price of Water 2015: Up
6 % in 30 Major U.S. Cities;
41 % Since 2010!

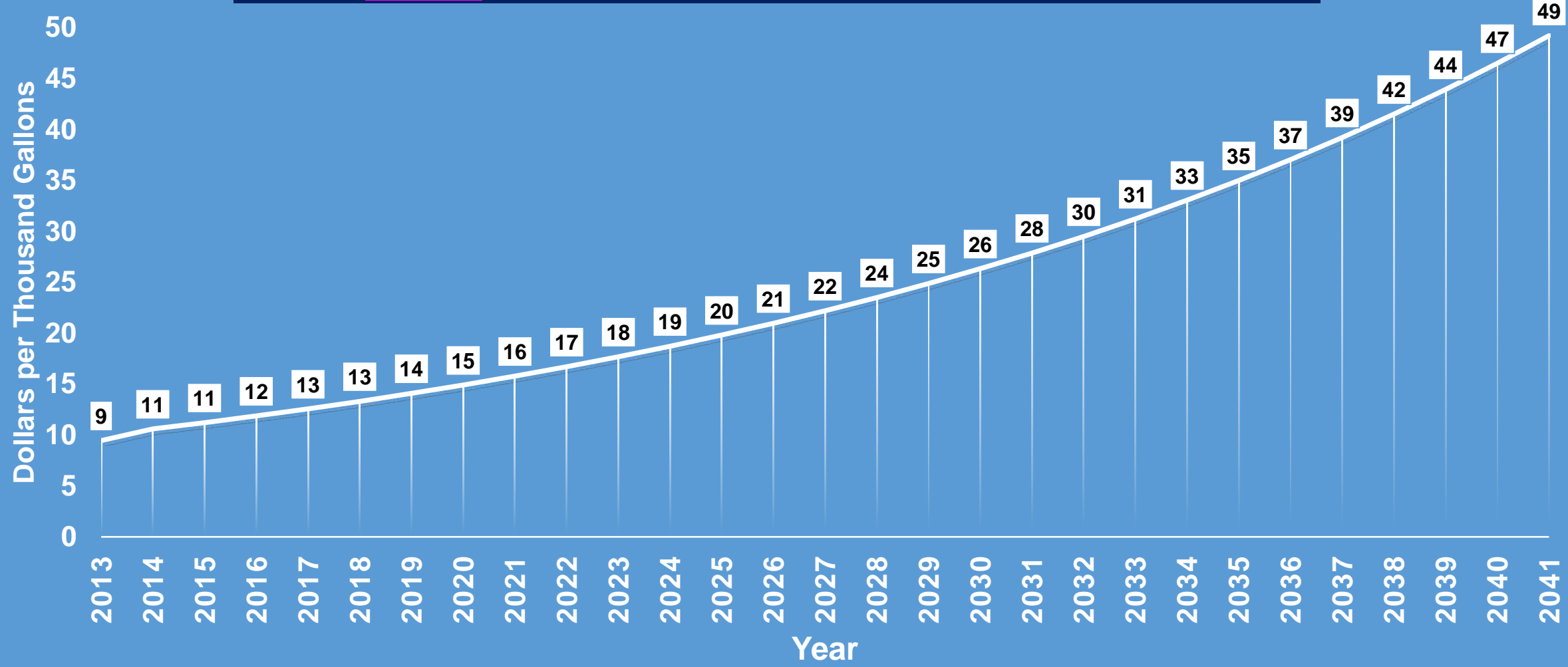
Commercial Combined Water and Sewer Rates For 50 Largest Cities in 2013

<http://bv.com/docs/management-consulting-brochures/50-largest-cities-brochure-water-wastewater-rate-survey>

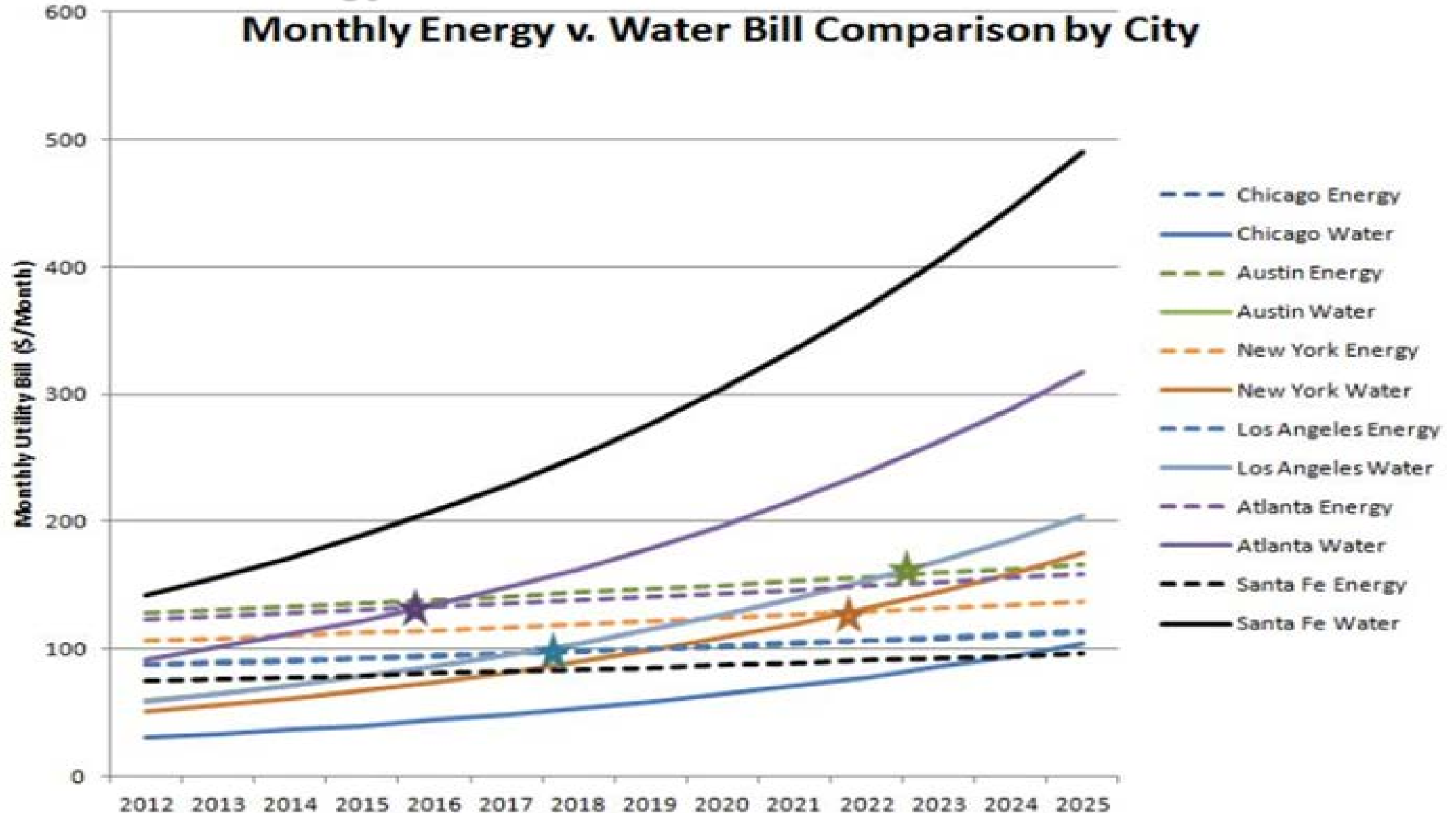


PROJECTED FUTURE COST OF WATER AT CURRENT INFLATION RATE OF 5.85%

A 4.27 FOLD INCREASE BETWEEN 2015 AND 2040



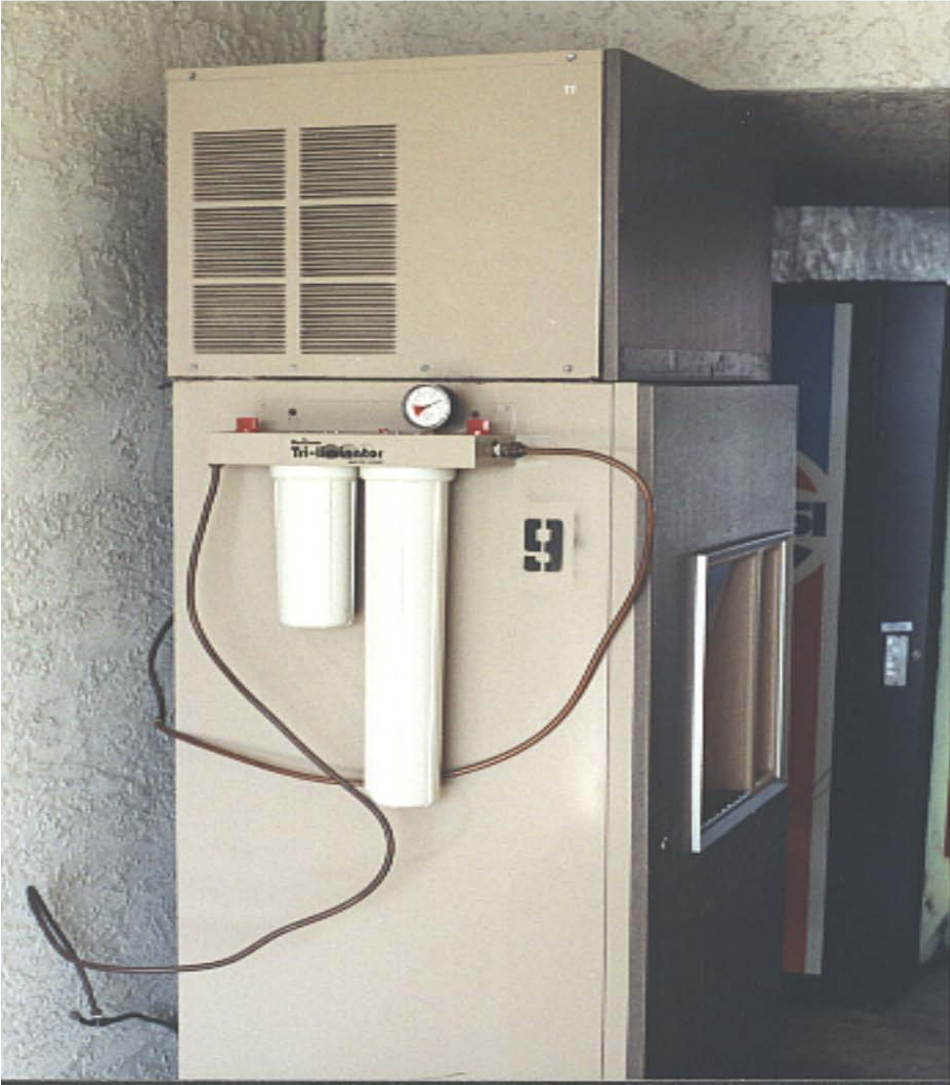
This graph shows when residential water and sewer bills will exceed energy bills in selected cities (source – Alliance for Water Efficiency)



Plumbers get ready!

\$\$\$\$

***Refrigeration
&
Ice Making***



Air cooled ice machine



Water cooled ice machine
(no louvers)

[Jump to first page](#)



Generalized Energy Recommendations from DOE for Ice Machines Used at Federal Facilities

Machine Capacity in Pounds of Ice Produced per Day	Kilowatt Hours for Air Cooled Machines	Kilowatt Hours for Water Cooled Machines	Difference	Energy Cost Savings (Cents per 100 pounds of ice @ 10)
500 to 750	<5.5	<4.1	1.4	14
750 to 1500	<5.0	<3.5	1.5	15
1500 up	<4.6	<3.4	1.2	12
Average Savings per 100 Pounds of Ice Based on Electricity at 10 Cents per kWh				13.7

Air Cooled Cost Savings Using DOE Latest Recommended Energy Standards for Ice Machines

At a water & sewer cost of only **\$2.50/Kgal!!!!**

Gallons per 100 lb.	Cost of Water and Wastewater Combined \$2.50 per kGal (Cents/100 Pounds)	Energy Savings per 100 Pounds With Water Cooled Equipment (Cents/100 Pounds)	Net Savings per 100 Pounds with Air Cooled Equipment (Cents/100 Pounds)
85	21.25	13.7	7.6
100	25	13.7	11.3
150	37.5	13.7	23.8
200	50.0	13.7	36.3

Air Cooled Cost Savings Using DOE Latest Recommended Energy Standards for Ice Machines

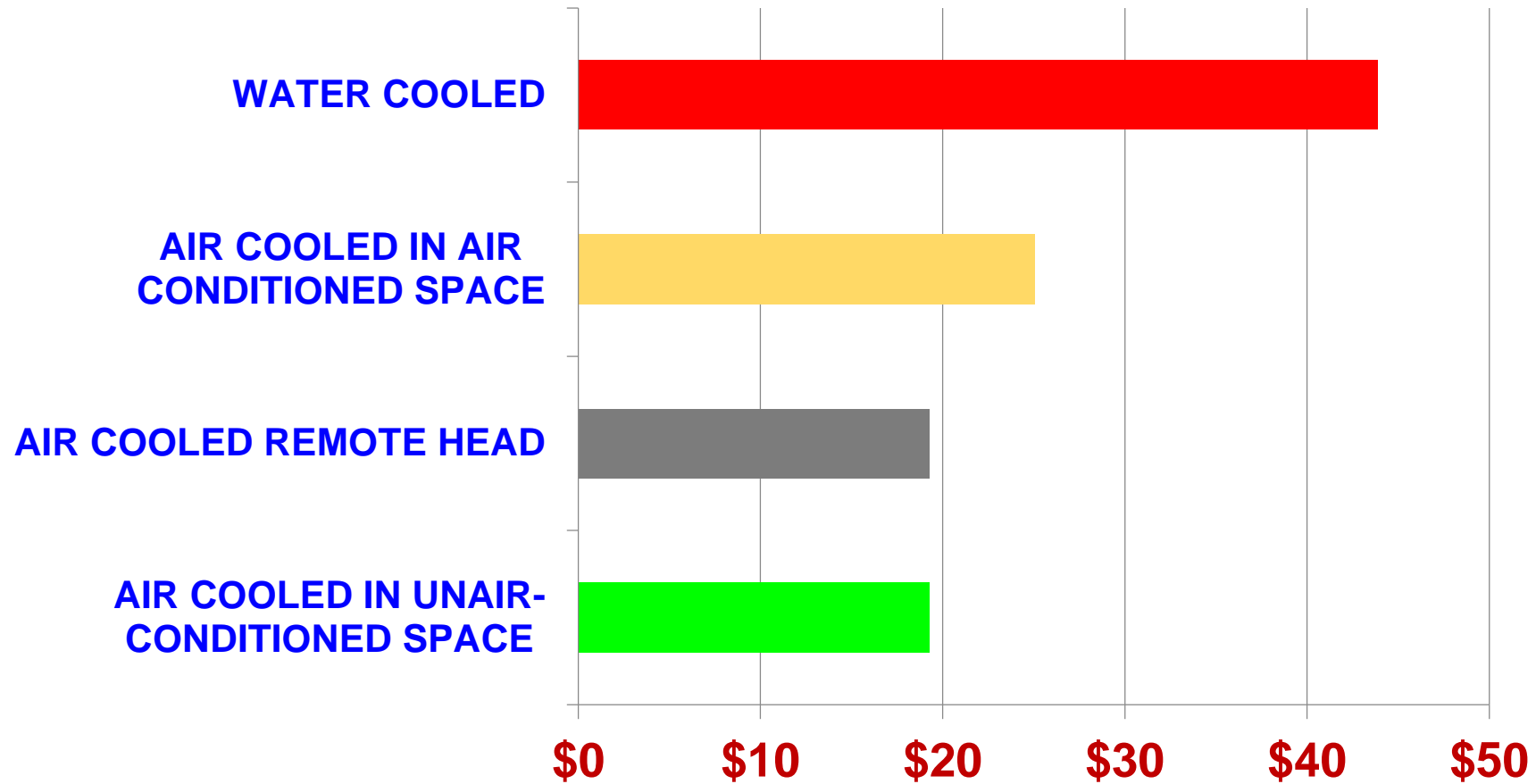
At a water & sewer cost of \$10 per 1,000 gallons

Gallons per 100 lb.	Cost of Water and Wastewater Combined \$10.00 per kGal (Cents/100 Pounds)	Energy Savings per 100 Pounds With Water Cooled Equipment (Cents/100 Pounds)	Net Savings per 100 Pounds with Air Cooled Equipment (Cents/100 Pounds)
85	85	13.7	71.3
100	100	13.7	86.3
150	150	13.7	136.3
200	200	13.7	186.3

At 150 gallons per 100 pounds of ice this means that you pay an extra \$1.36 for the ice with water cooled equipment

Lifetime Utility Cost Analysis

1,000 lb/day machine, Water \$7.60/kGal. Elec. 10 cents/kWh, 120 gallons of cooling water, DOE Recommended Efficiencies

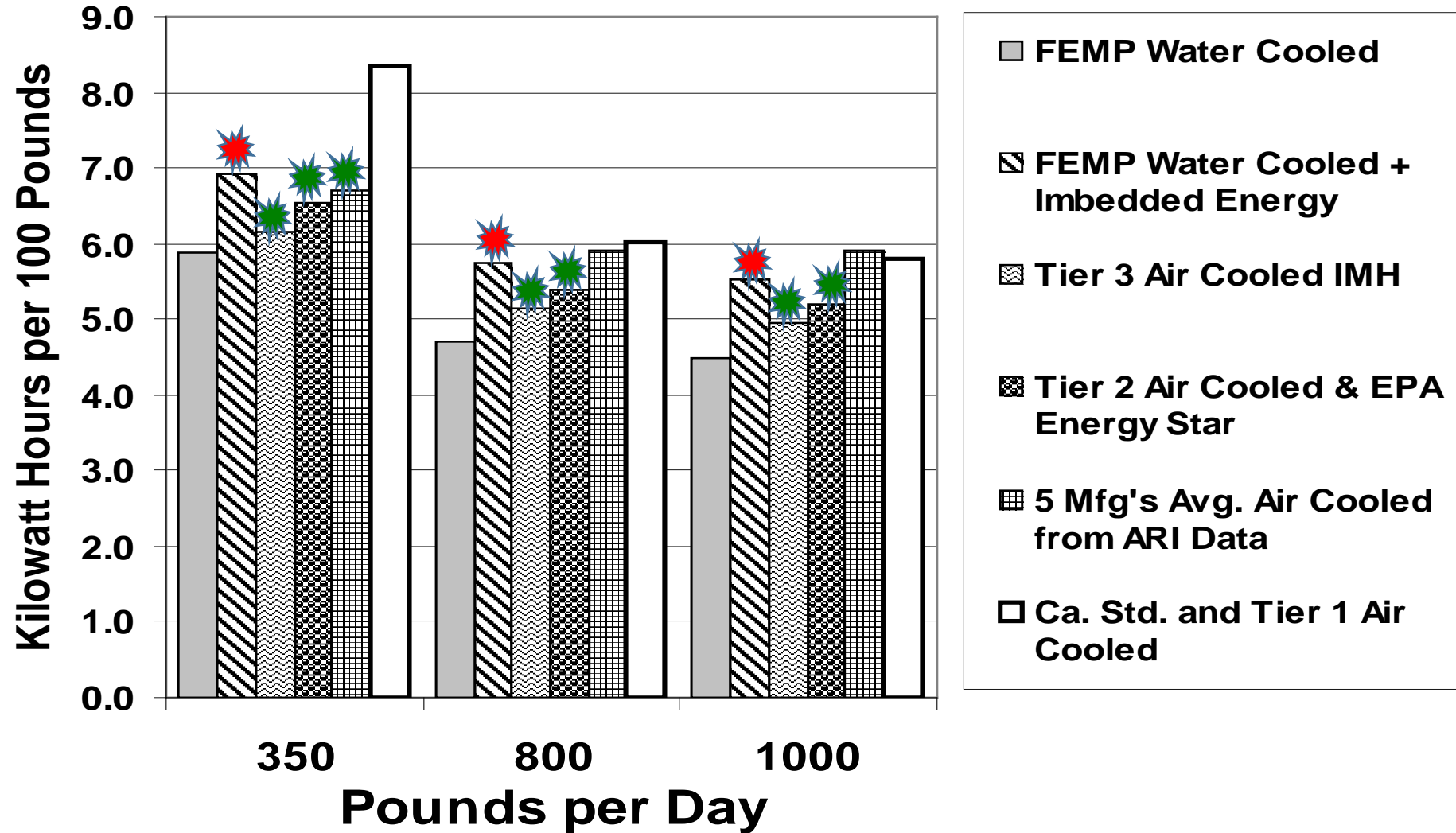


Thousands of Dollars over 8.5 Year Lifetime

**And then there is the
embedded energy in the
cooling water!**

Figure 6. Comparison of Energy Use for Ice Making Head Machines

Including Imbedded Energy for Cooling Water



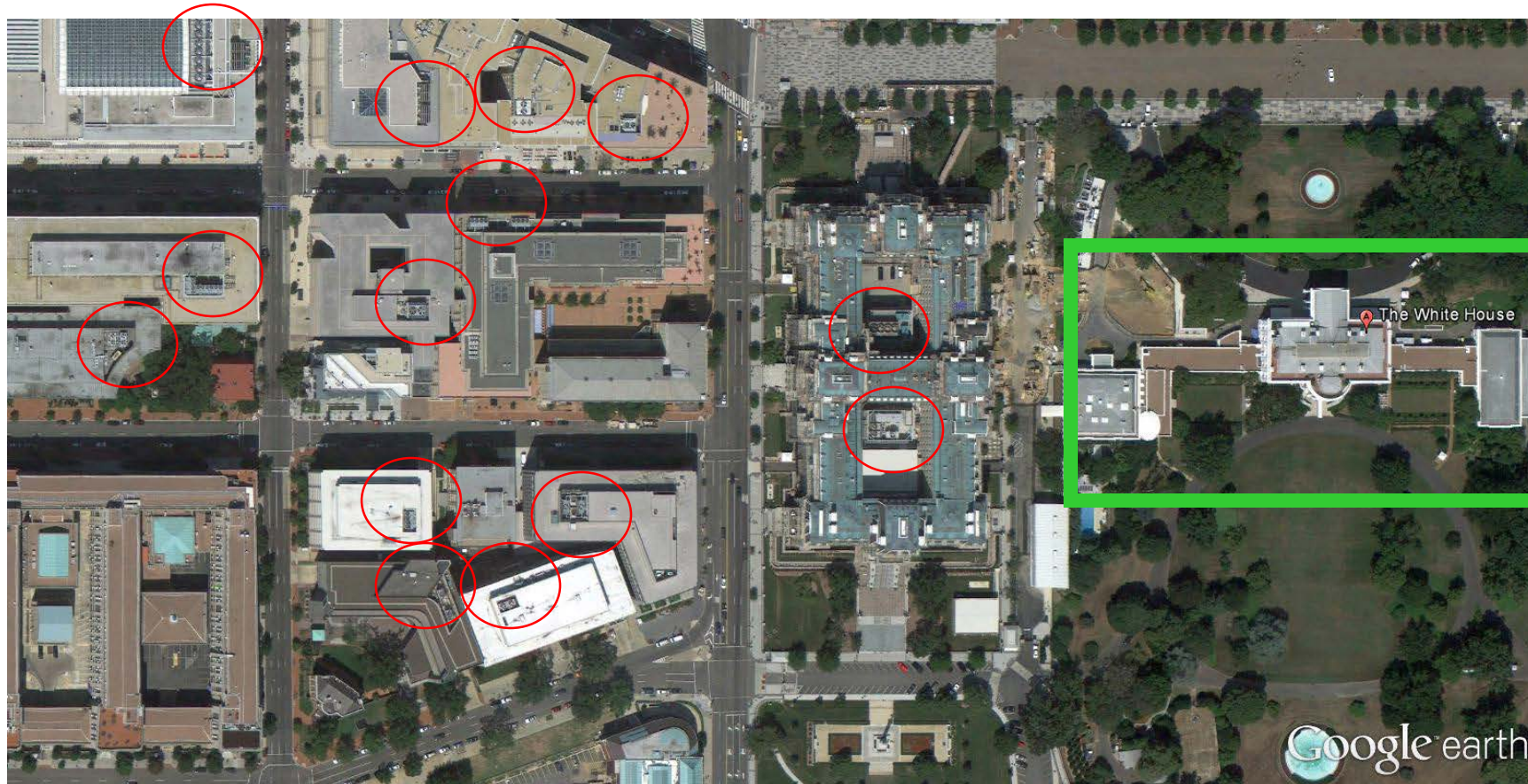
The True Cost of Water
for Cooling Tower Use

The Energy – Water
Nexus of Cooling
Towers

You may recognize the Building outlined in Green

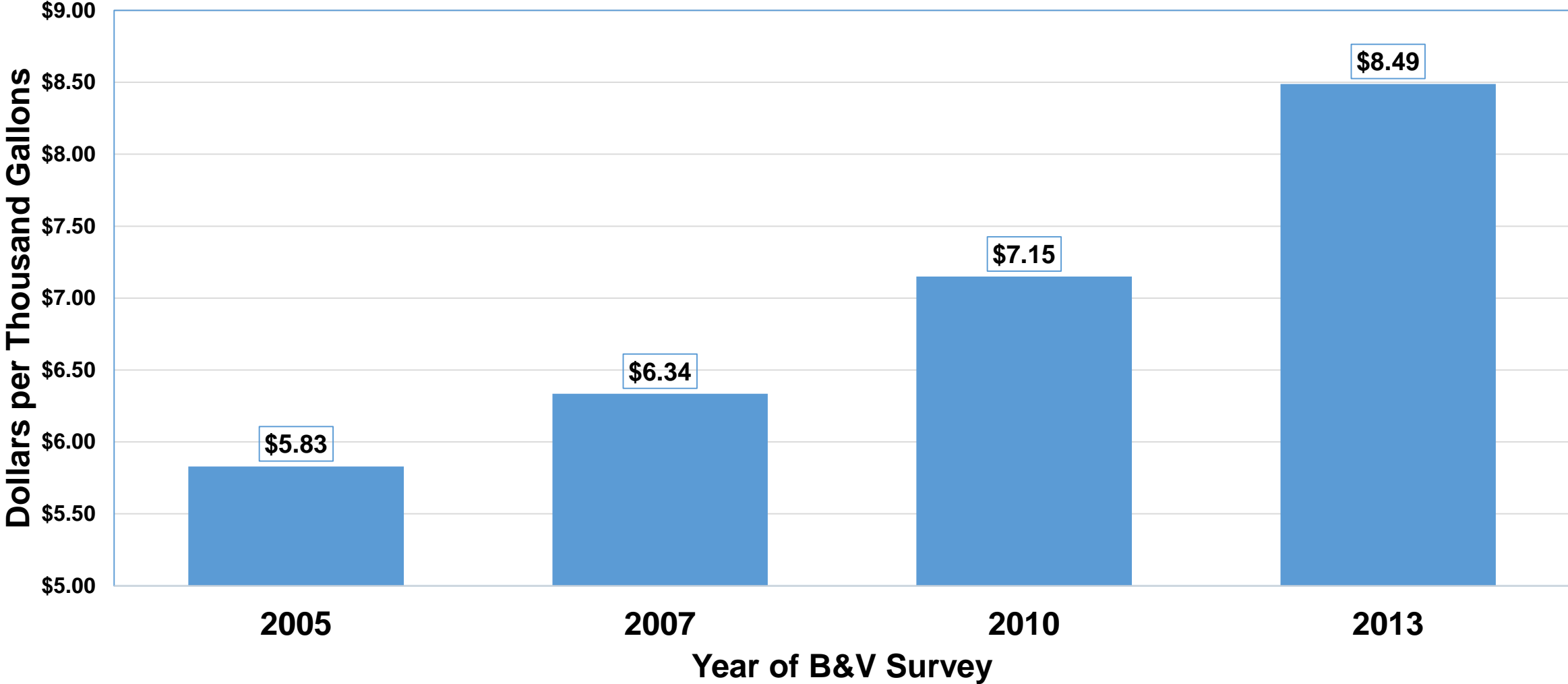
Red circles show cooling towers

The Whitehouse and downtown DC



Average Water & Wastewater Rates for Six Largest Cities in Texas

Austin, Dallas, El Paso, Fort Worth, Houston, & San Antonio
Source: Black & Veatch Reports for Top 50 Cities in USA



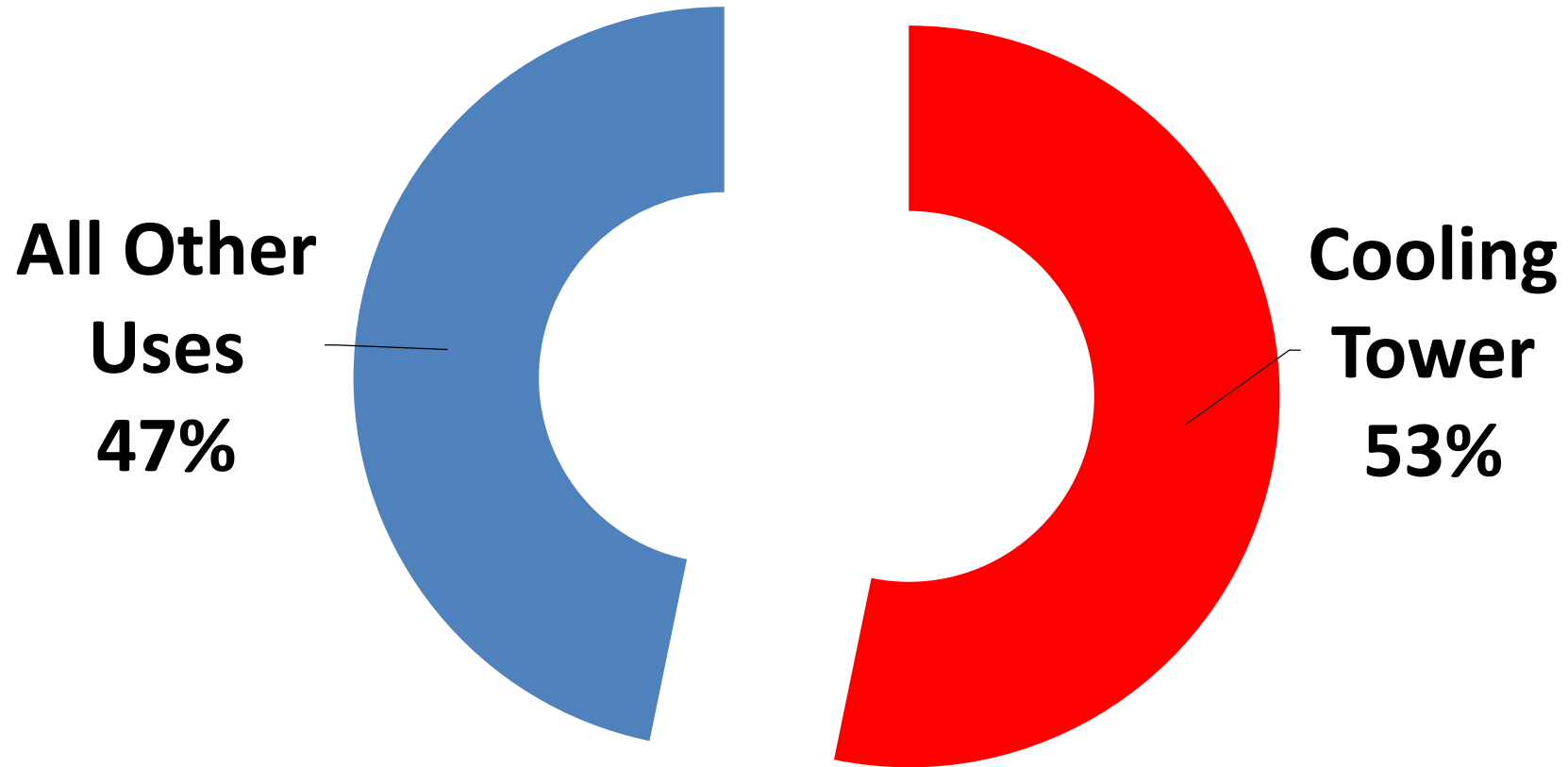
Cooling Towers

The purpose of a cooling tower is to get
rid of

unwanted energy!

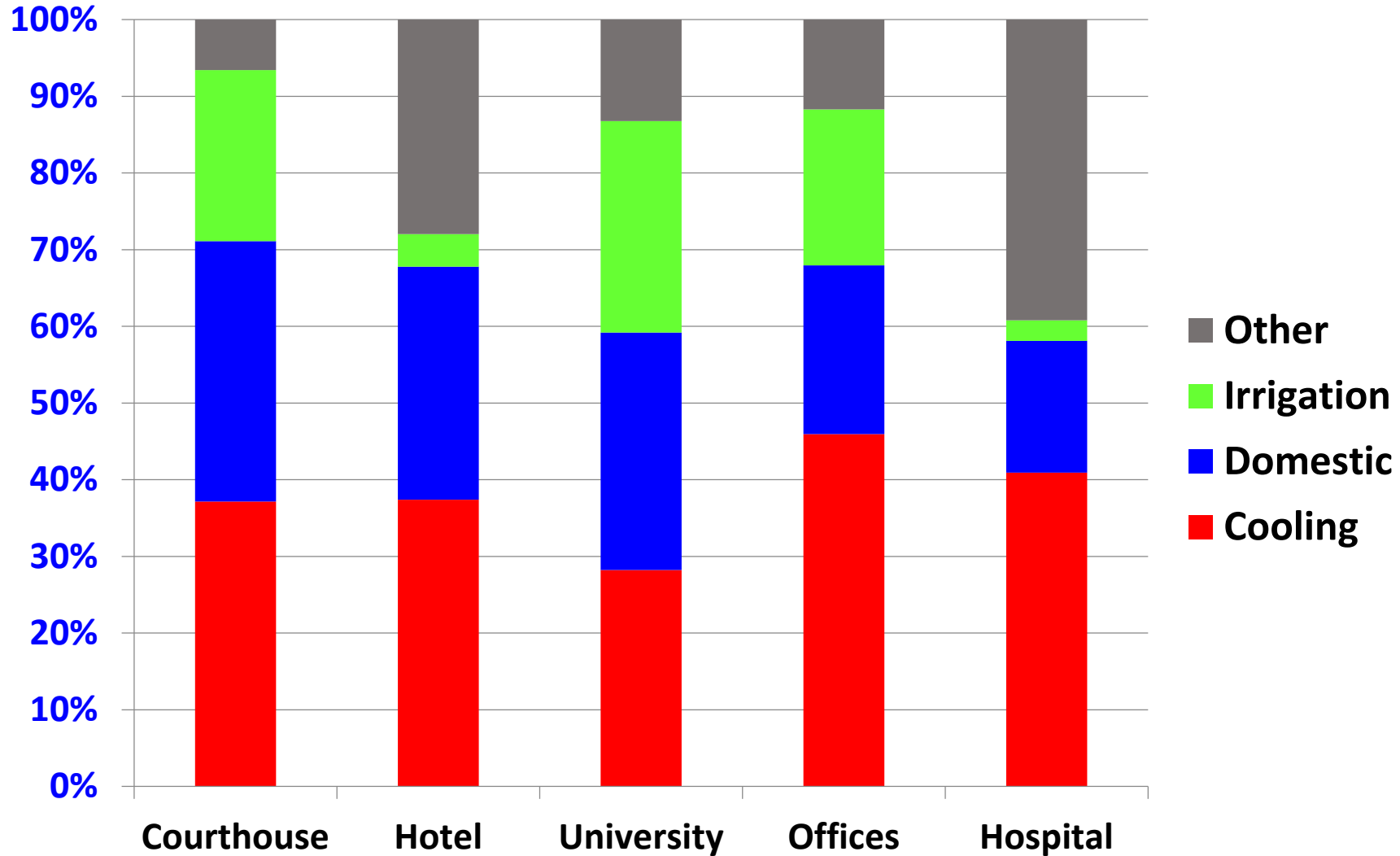
Cooling tower use can be *HUGE!*

Eleven Office Buildings in Austin, Texas

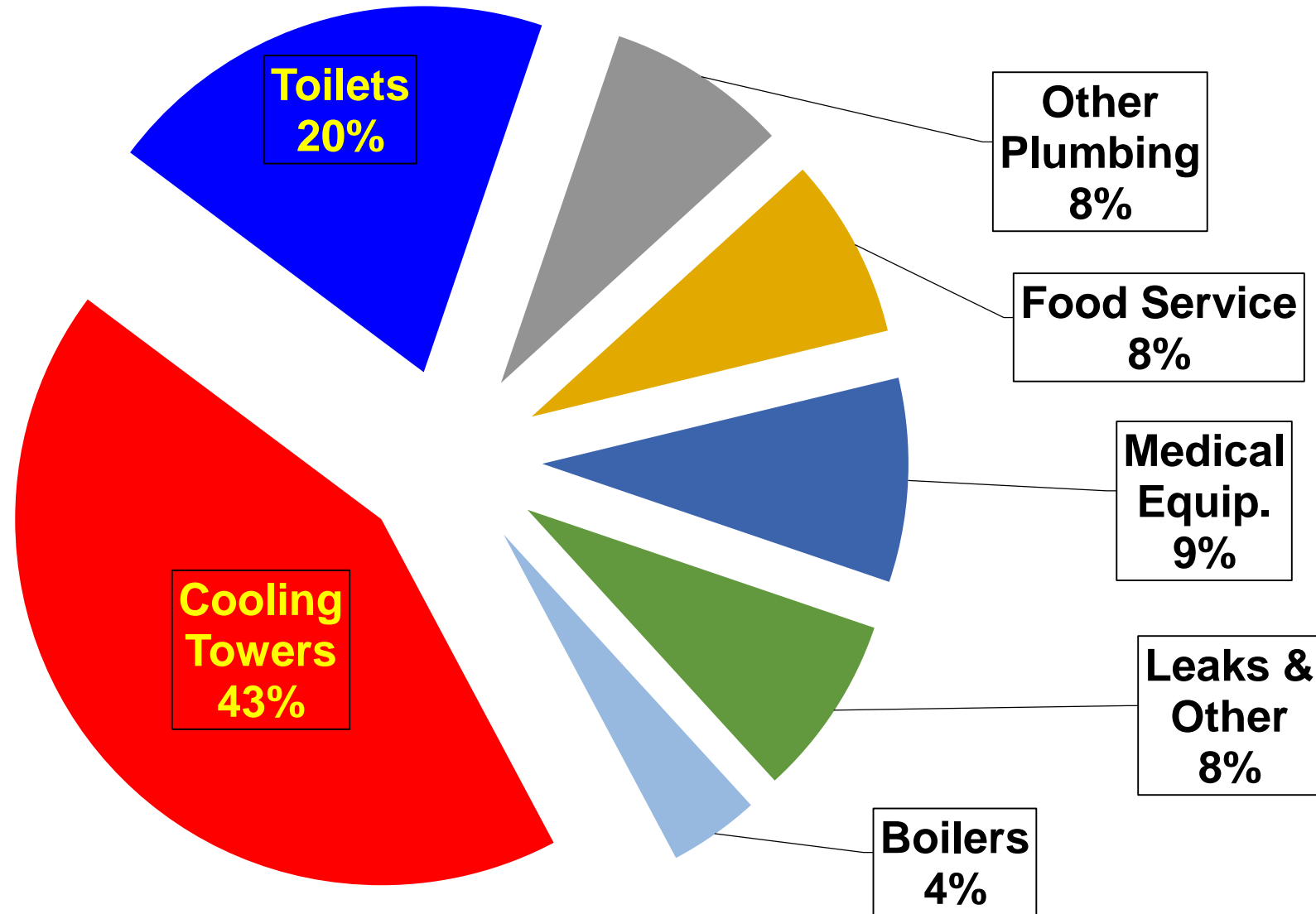


Summary of Audits of 30 Large Facilities with Cooling Towers in Downtown Fort Worth Texas

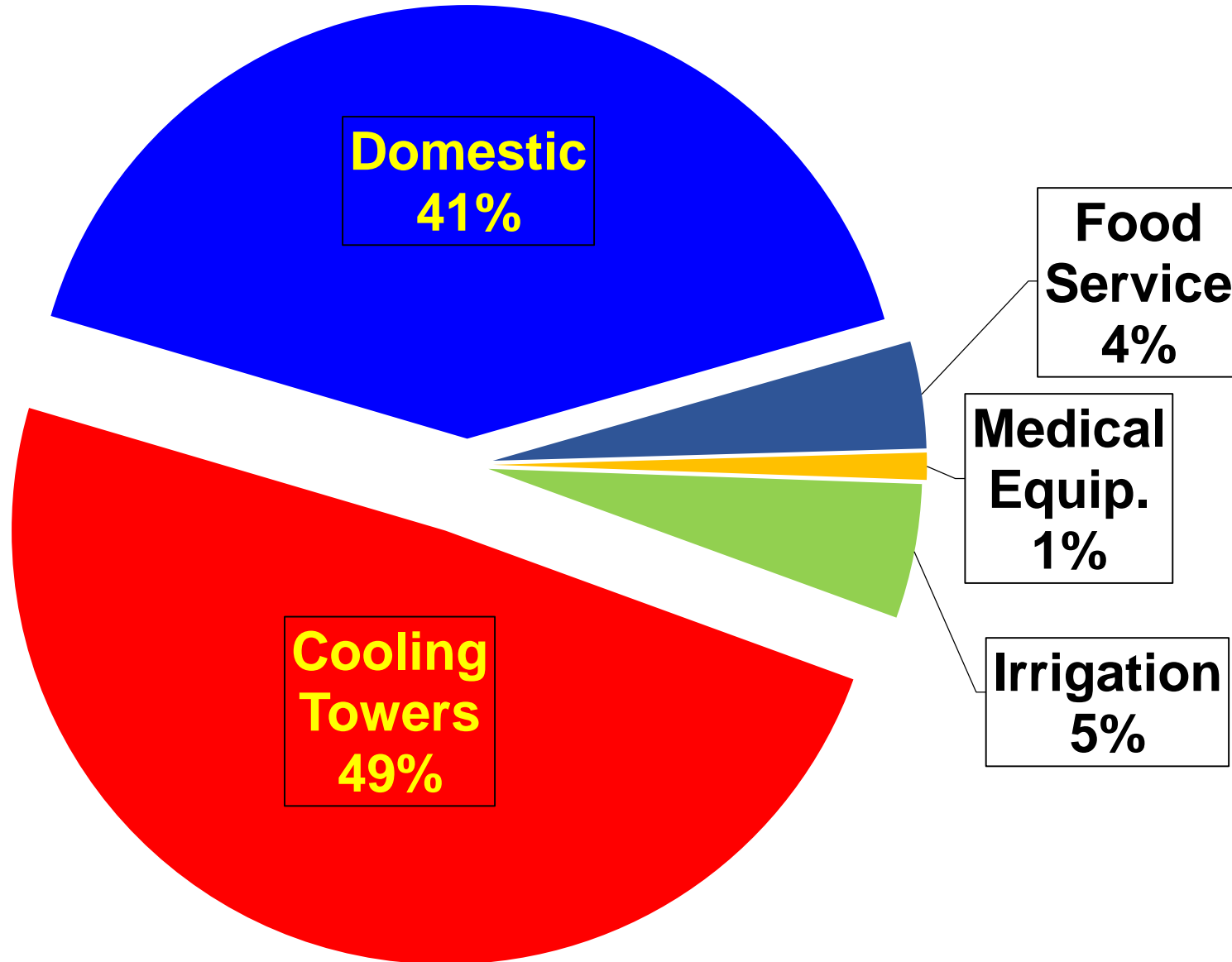
Water Management, Inc.



A Large Hospital in Florida

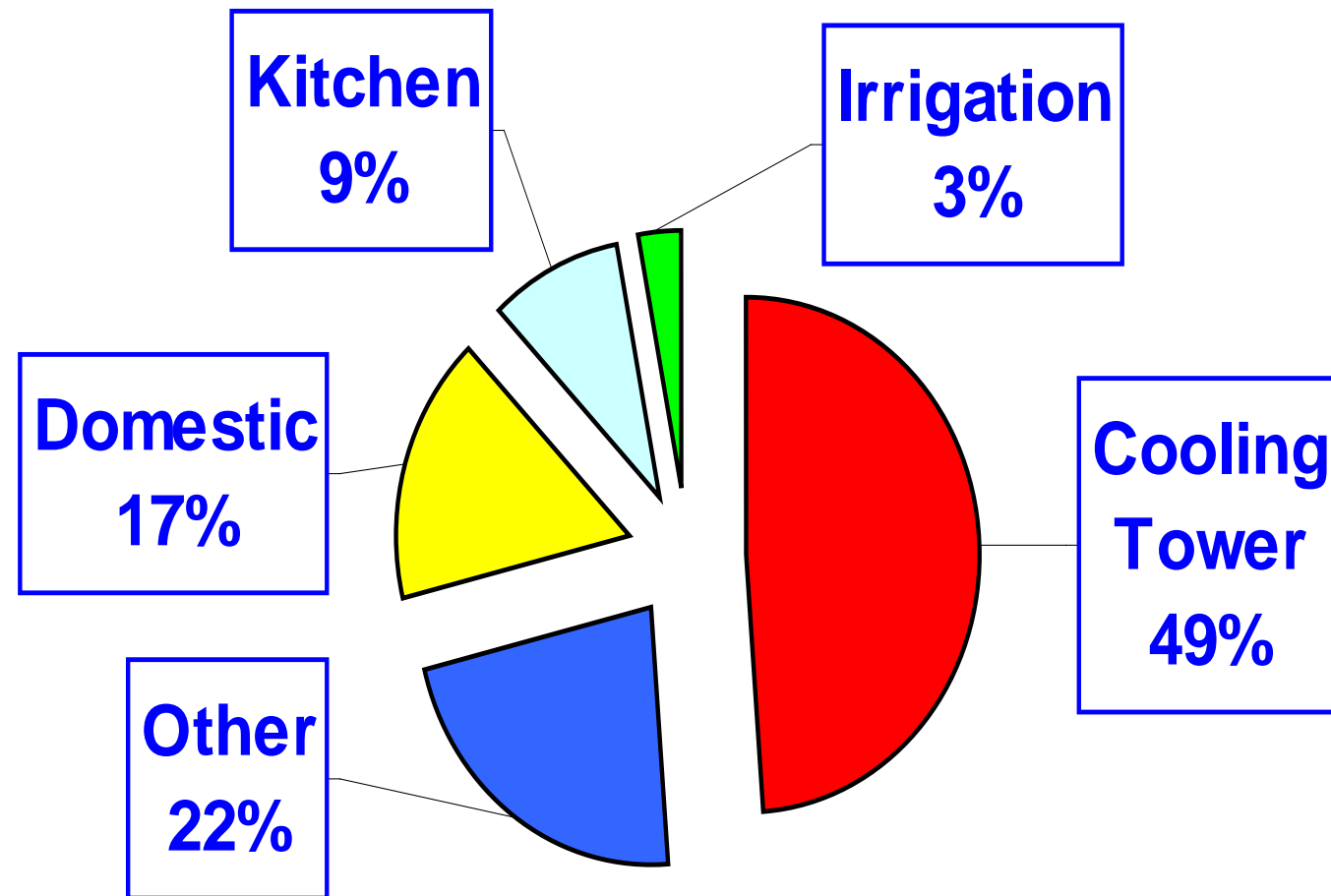


A Large Hospital in Arizona

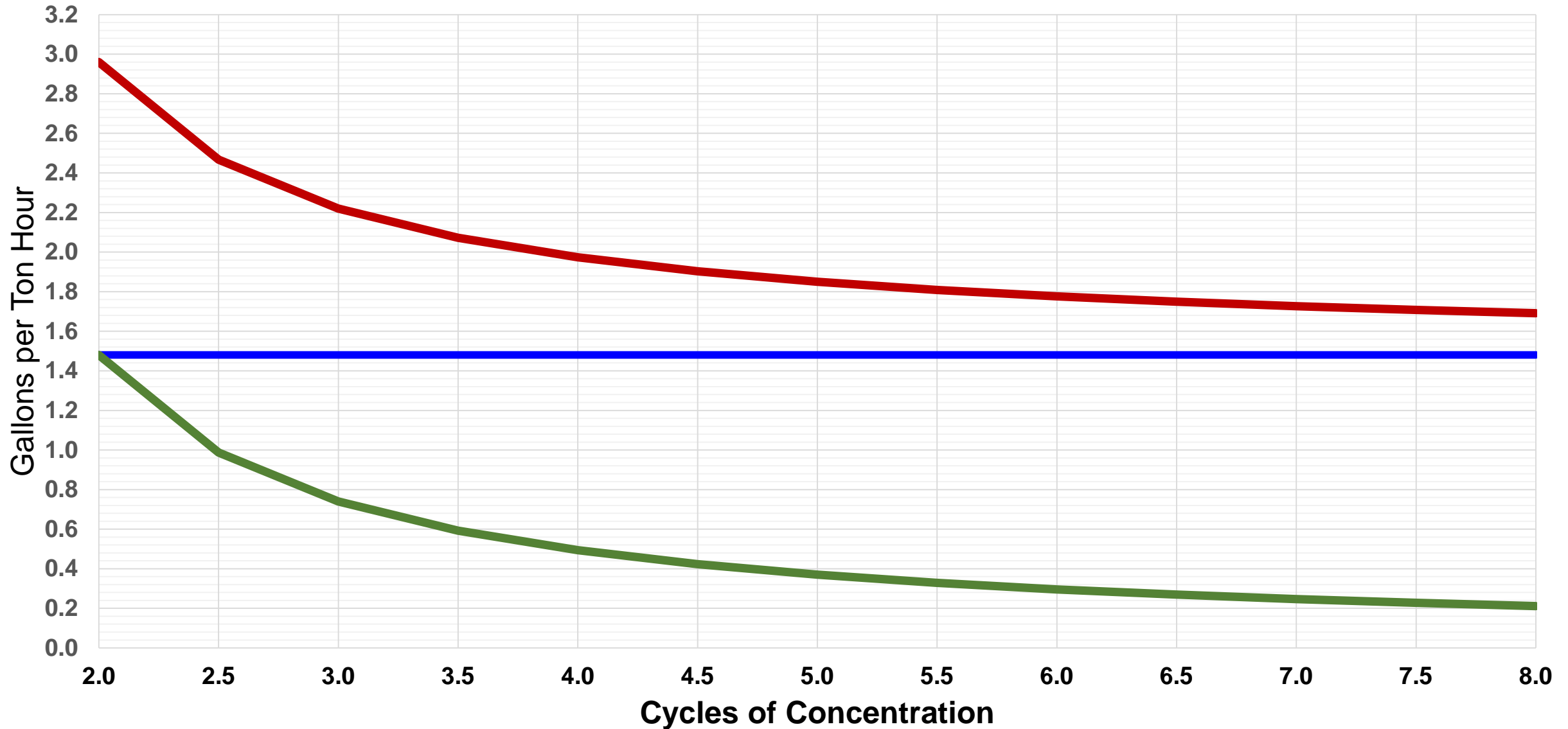


Grocery Store Water Use in California

Pacific Institute



Make Up, Blowdown and Evaporation vs. Cycles of Concentration



Savings With Cooling Tower

Energy savings
0.3 to 0.4 kWh/Ton-Hr

Equal to about
3.0 to 4.0 cents
in most markets

And again -

The True Cost of Water

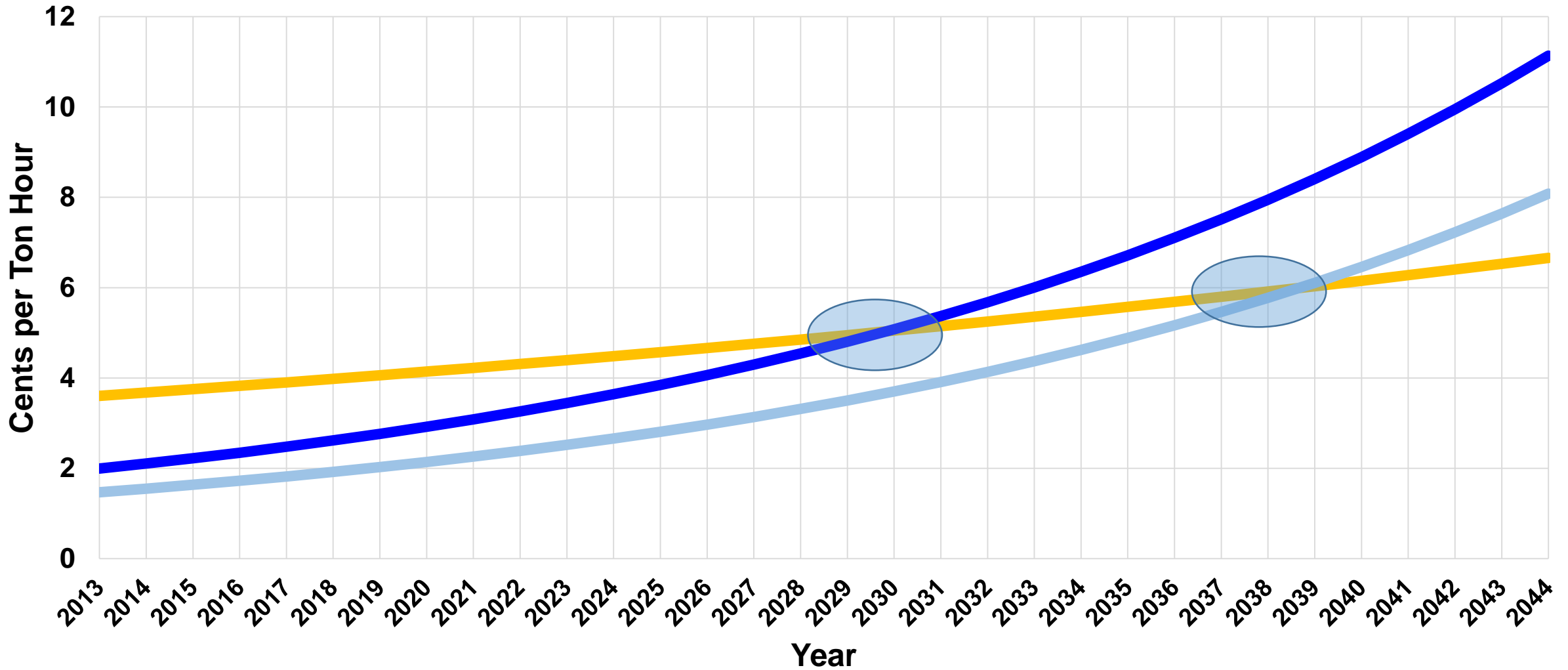
- Water Cost
- Sewer/Pre-treatment
 - Energy
 - Chemicals
- Solid Waste Disposal
 - Capital Equipment
 - Labor
 - Liability

Total Water Associated Costs per Ton Hour Should Include:

- The cost of water in cents per ton hour
- The cost of sewer in cents per ton hour
- The cost of water treatment per ton hour
- The cost of labor and maintenance per ton hour

Graph of Water, Sewer & Water Treatment Costs Vs. Electric Energy Savings With Chilled Water/Cooling Tower Air Conditioning

Assumes a savings of 0.35 kWh/ton hour with cooling tower and national average water use of 2.0 gallons per ton hour



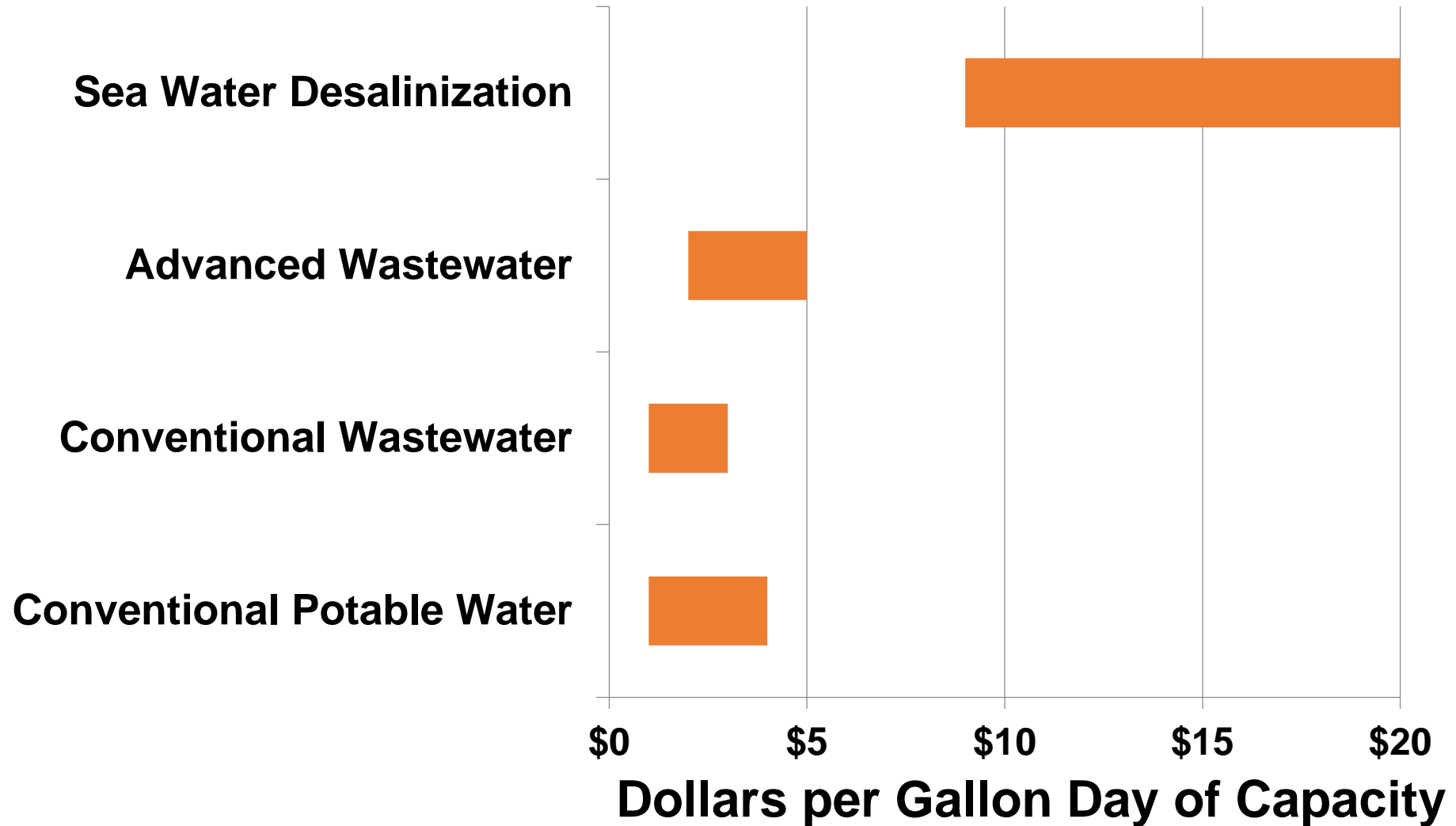
Example of a 750 Ton System

- On the hottest day assume it operates at 75% of capacity over that 24 hour period which corresponds to a high irrigation day for the water utility also. *(It adds to peak water use)*
- The system has a 20% load factor for the year.
- Cooling tower makeup is 2.5 gallons per ton hour.

Water Use by 750 Ton System

- Water use on peak day at 2.5 gallons per ton hour & 75% capacity=
33,750 gallons
- Water use annually at 2.5 gallons per ton hour & 20% capacity=
3,285,000 gallons

Capital Cost of Water and Wastewater Treatment



The Impact to the Utility and You

- Peak day use – 33,750 gallons a day added to peak day water treatment capacity requirements. Peak cooling day closely corresponds to peak water use day for utility.

Water Treatment Capital Cost to Support Cooling Tower

This is what a cooling tower costs the water utility.

A total hidden but real cost to the society!

Dollars per gallon day of capacity	\$2	\$5	\$10	\$15
Cost of Treatment Capacity	\$67,500	\$168,750	\$337,500	\$506,250
Capital Water Cost per Ton	\$90	\$225	\$450	\$675

Example of Water Reduction through Energy Conservation from a Phoenix Study

Estimated Reduction in Water Use in Cooling Towers per Year Between 2003 and 2013 for Commercial Buildings in Phoenix due to Energy Efficiency Improvements.

Type of Facility	Percent Reduction in Total Water Use	Reduction in Use in Gallons per Square Foot per Year Due To Energy Efficiency Improvements 2003-2013		
		Internal Reduction ¹ .	Air Conditioning System	Total Reduction in Water Use
Schools	13%	0.9	1.7	2.6
Large Office Building	14%	1.1	2.0	3.1
Large Retail	14%	1.2	2.3	3.5
Hotel Motel	13%	1.0	2.6	3.6
Colleges	12%	1.4	2.3	3.8
Health Care	11%	1.1	3.3	4.4
Grocery Stores	14%	2.3	4.1	6.4
Hospital	14%	1.6	6.0	7.6

1. Reduction in water use due to increase efficiency of lighting, equipment, cooking and ventilation.

Ways other than a cooling tower

- **Direct Exchange (DX)**
- **Variable Frequency Drive Air Cooled**
- **Geothermal**
- **Thermal absorption and desiccant systems**
- **Hybrid Cooling towers and evaporative condensers**

We need to start the
discussion to rethink the

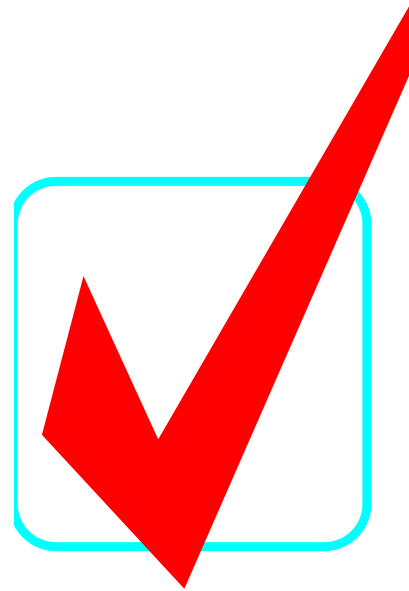
Energy Water

Nexus of the

End User!

Could this be the
next big incentive
for water
conservation from
the energy side???

The



End

The Energy Water Nexus of the End User



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