The Energy – Water Nexus of *Cooling Towers*

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Phoenix Industrial, Commercial & Institutional Water Demand Research

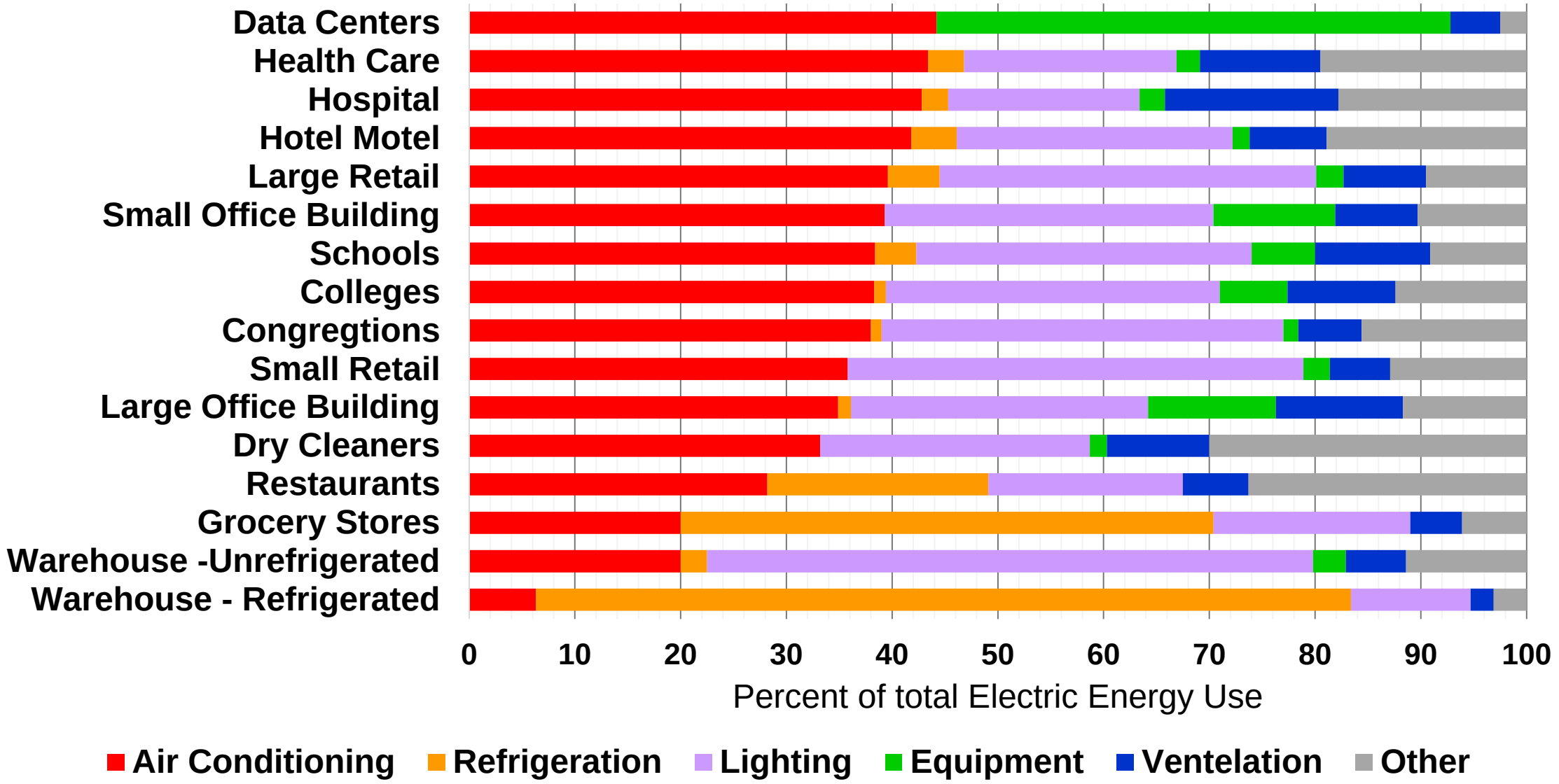
- City of Phoenix Water Services Department interested in improving accuracy of medium and long-range projections
- Least understood component of demand is ICI
- ICI research/projections is following model used for SF and MF research/projections
- Emphasis is on end-use and ‘building block’ analysis
- Attempts to break down demand into functional components for each sector such as laundry, washroom, irrigation, cooling, etc.

Cooling System Research

- Preliminary research focused on towers
- Inventories created of cooling tower locations
- Currently in process of developing detailed database including estimates of:
  - Type of customer and amount of space cooled
  - Type of building and cooling tower characteristics
  - Operational patterns and management
- *Investigation of energy/water nexus*

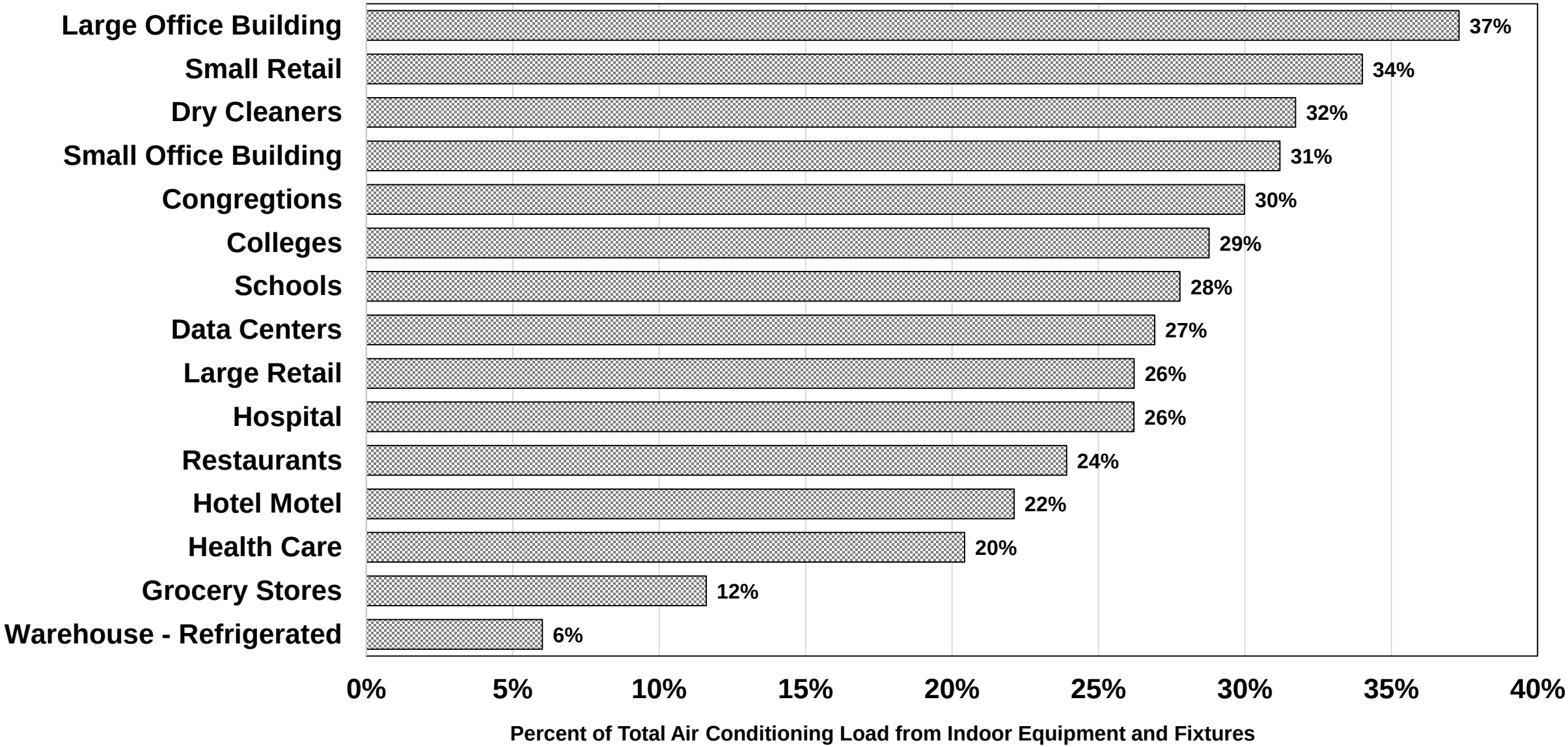
Electric Energy Use by Type of Facility in Phoenix

Source: http://www.savewithsrpbiz.com/generaluse.aspx



Percent of Potential *Air Conditioning Cooling Load* From Indoor Equipment and Fixture Use Including, Lights, Ventilation, Computers, Etc. in 2013

Does not include water heating and space heating.

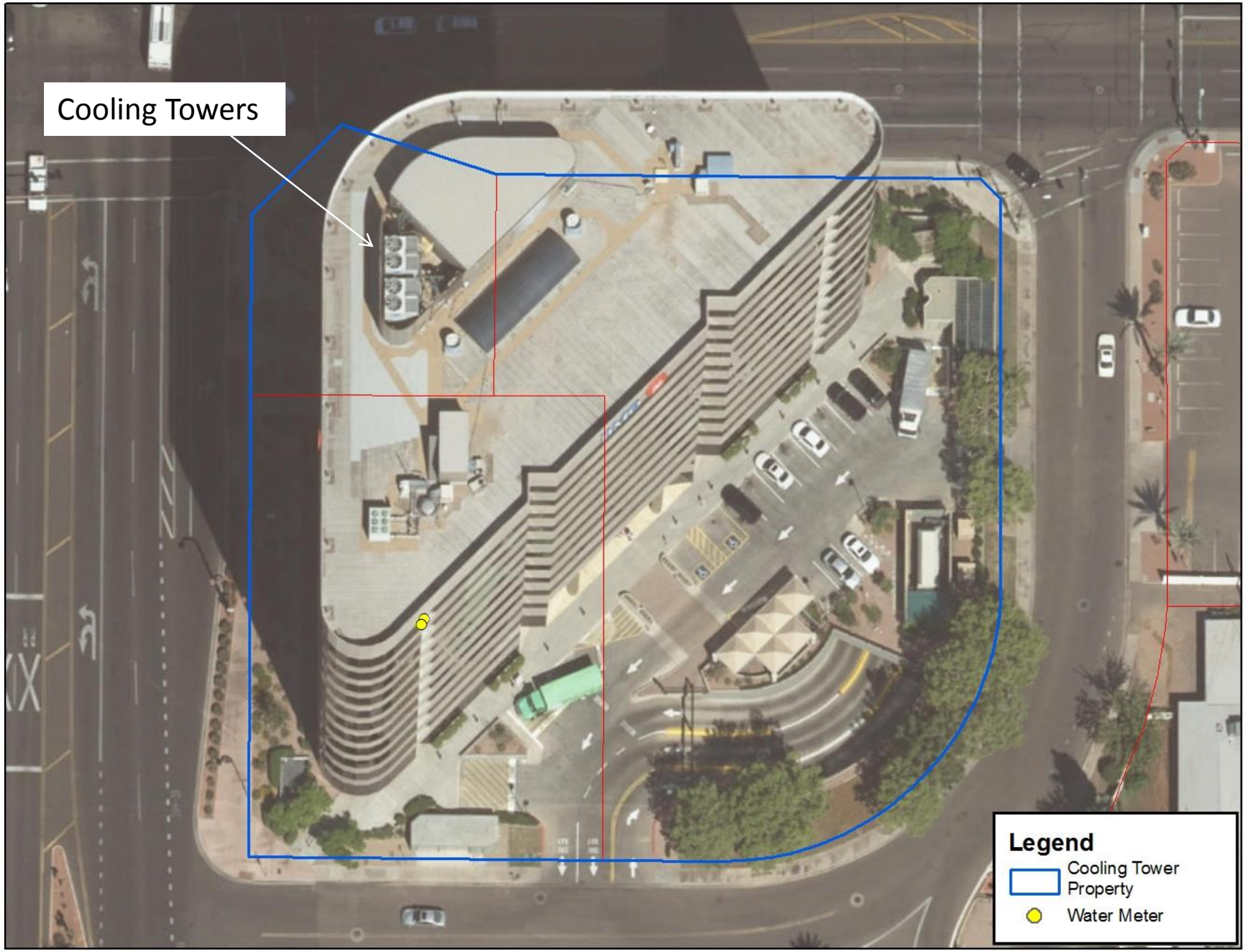


Estimated Percent Changes in Energy Efficiency Between 2003 and 3013		
Type of Equipment	***Percent Decrease/ Increase in Efficiency***	***Notes***
Air Conditioning Equipment	***10% Increase***	
Lighting	***25% Increase***	
Ventilation	***No change***	
Equipment & Other	***10% Decrease***	
Cooking	***15% Increase***	***Both electric load and nat. gas***
Data Centers	***Note***	***Energy use went up, but predication not possible***

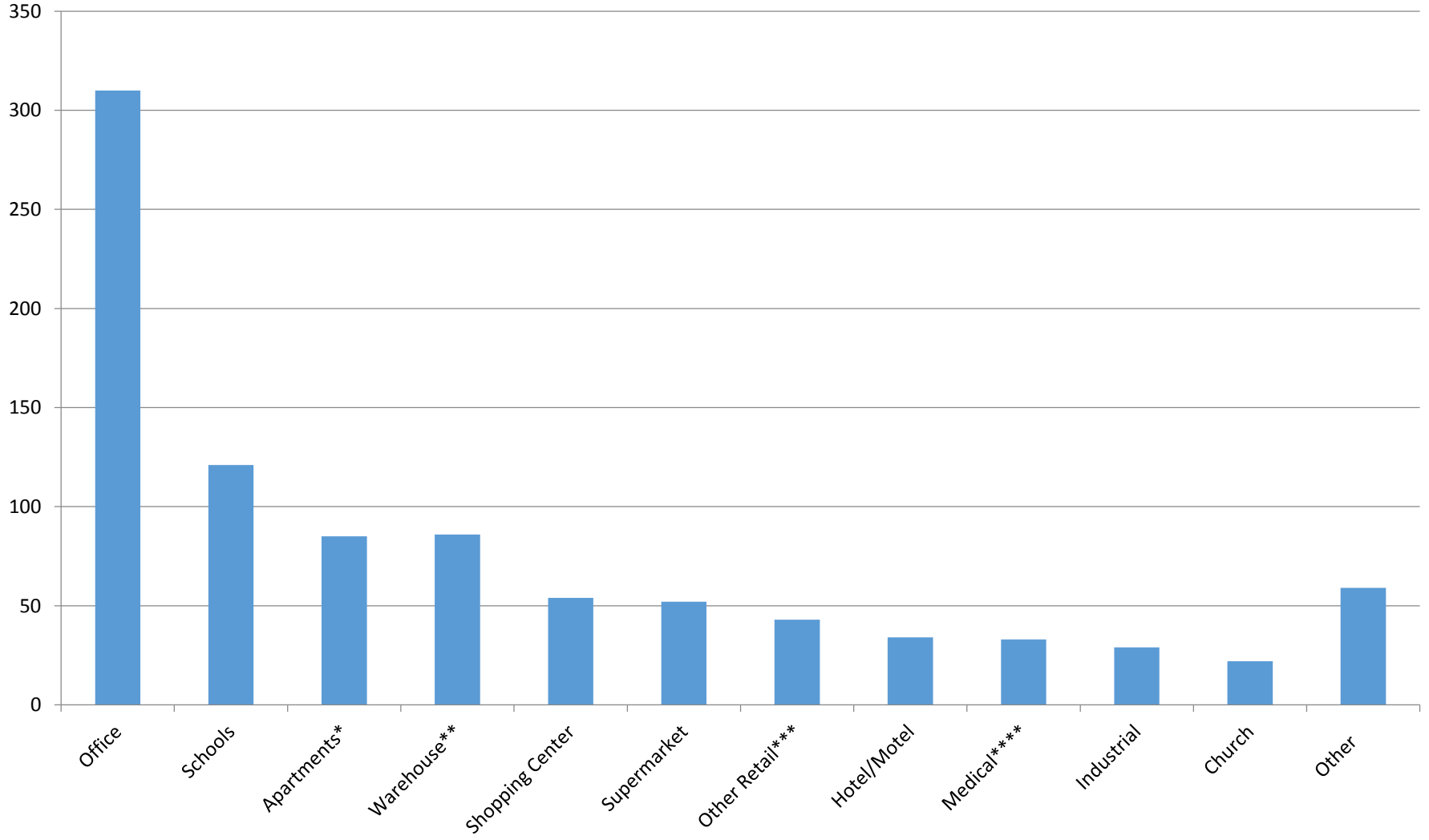
Estimated Reduction in Water Use in Cooling Towers per Year Between 2003 and 2013 for Commercial Buildings in Phoenix due to Energy Efficiency Improvements.

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.


Cooling Towers
Legend
Cooling Tower Property
Water Meter

Identified Properties With Cooling Towers
City of Phoenix, By Sector, 2014 Study

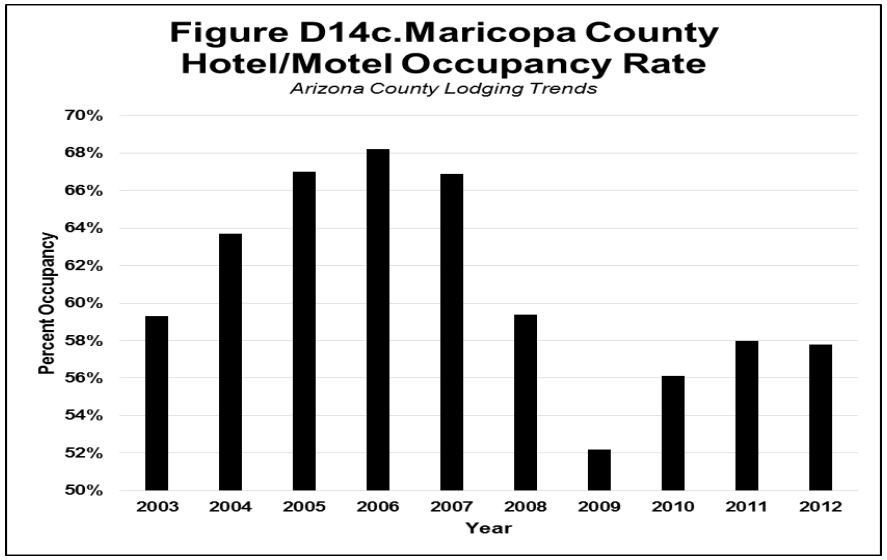


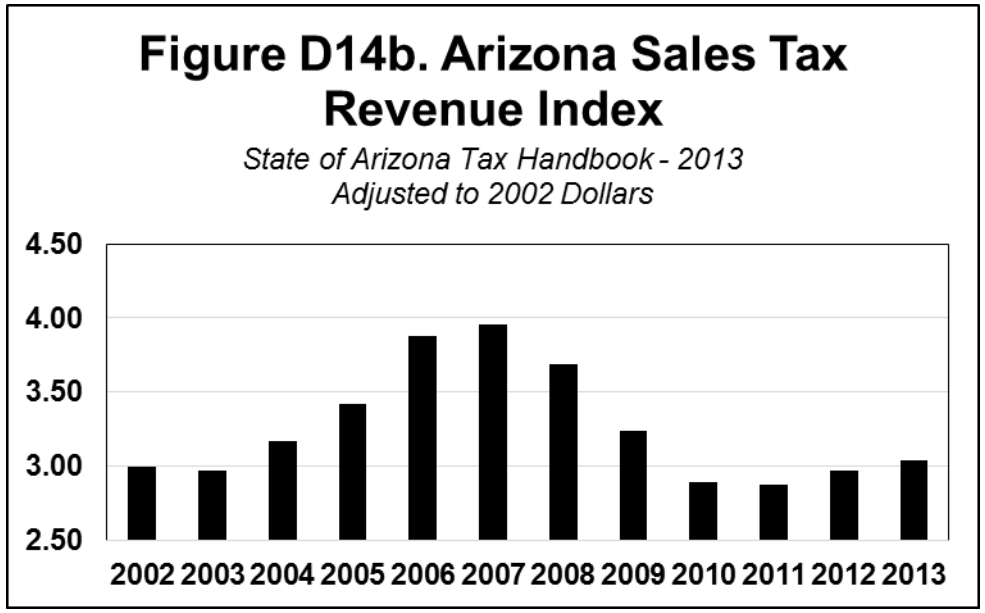
Estimated Reduction in Water Use Due to Energy Efficiency Improvements, 2003-2013, For Structures with Cooling Towers (Gallons per Year per 1,000 Sq.Ft.)

Type of Facility	Reduction in Water Use
Schools	2,600
Large Office	3,100
Large Retail	3,500
Hotel/Motel	3,600
College/University	3,800
Grocery Stores	6,400
Hospital	7,600

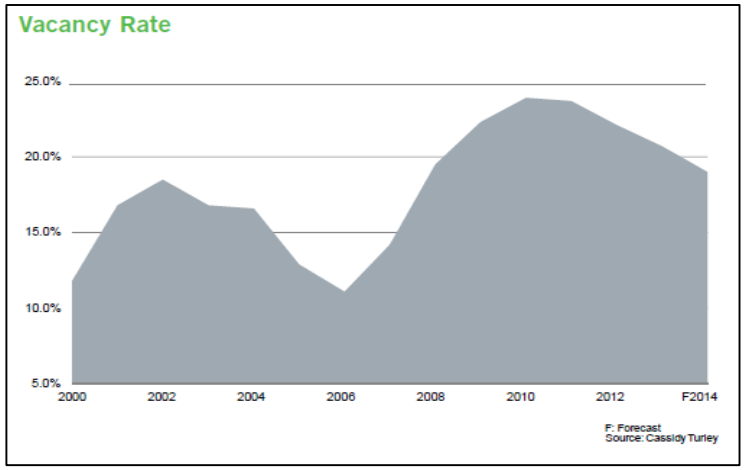
One of the most intriguing results of initial research into cooling towers is that improvements in air conditioning, lighting, and other device energy efficiency, and therefore heat loading, is likely leading to significant cooling tower water use reductions (up to 14% from 2003 to 2013)

Economic Impacts

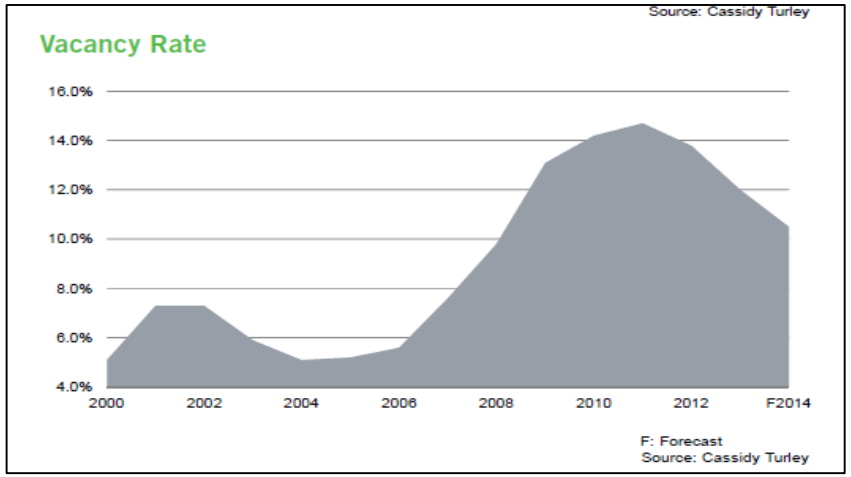




Office Space



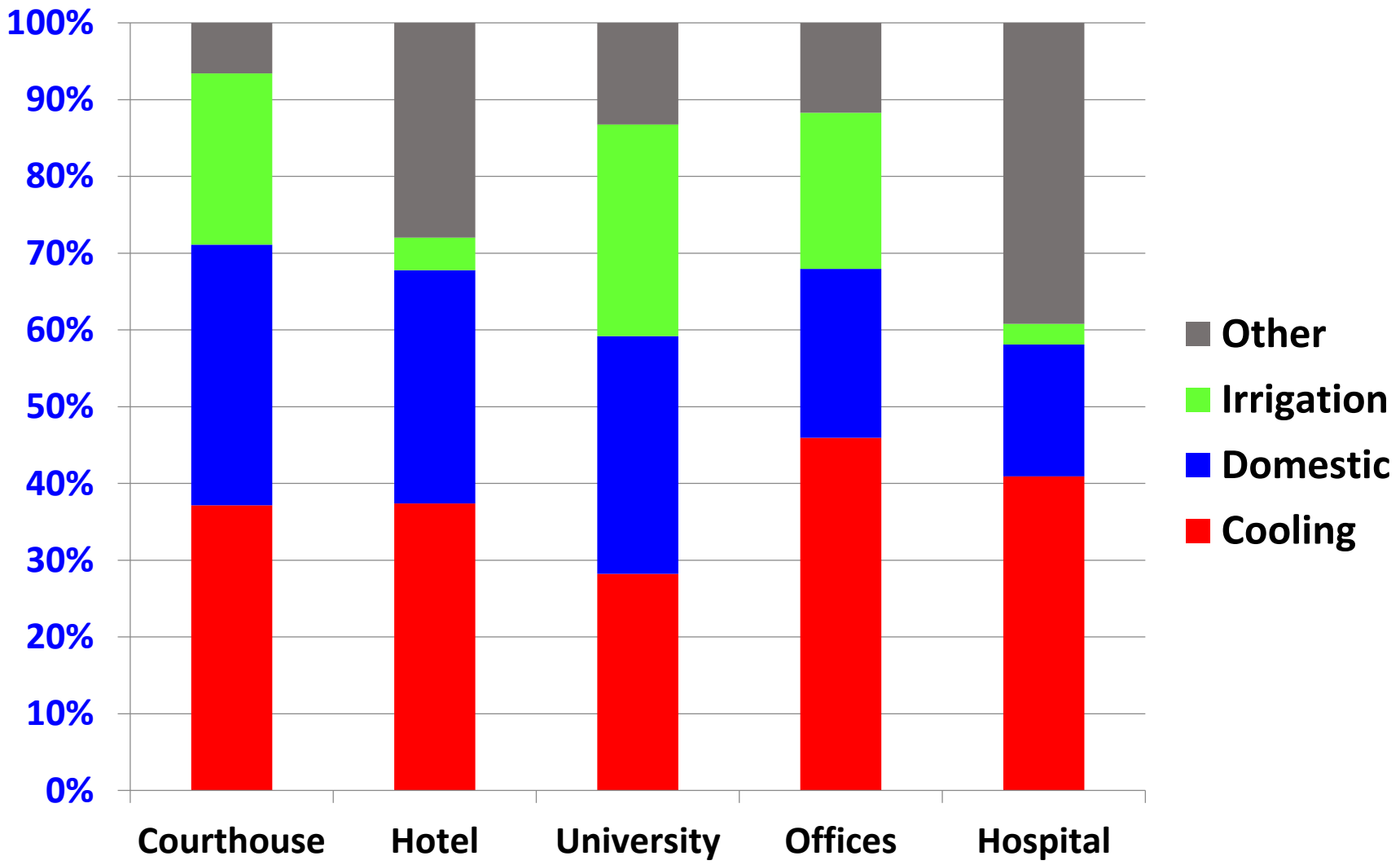
Retail Space



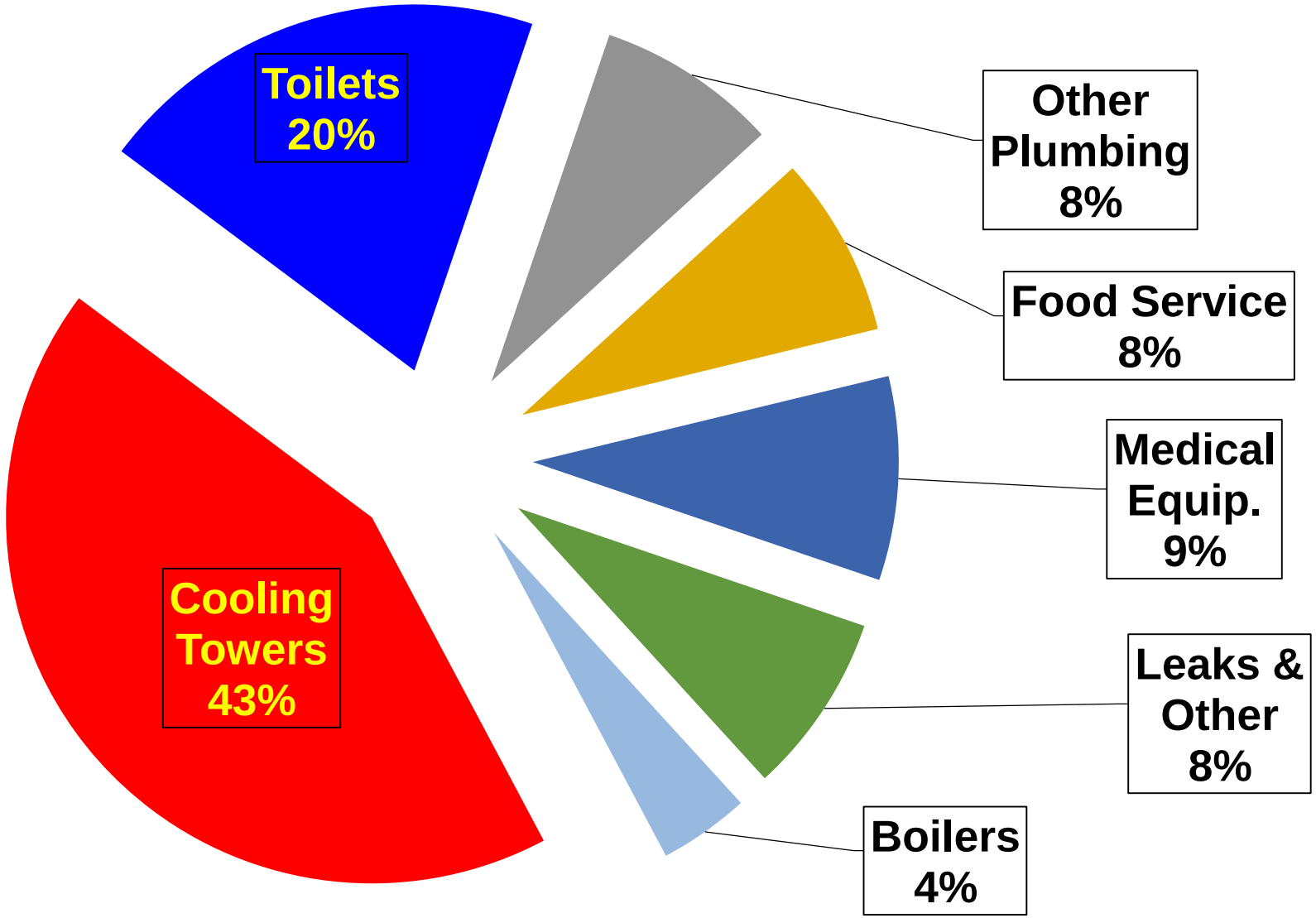
A look at water use for cooling towers across the South and Southwest

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

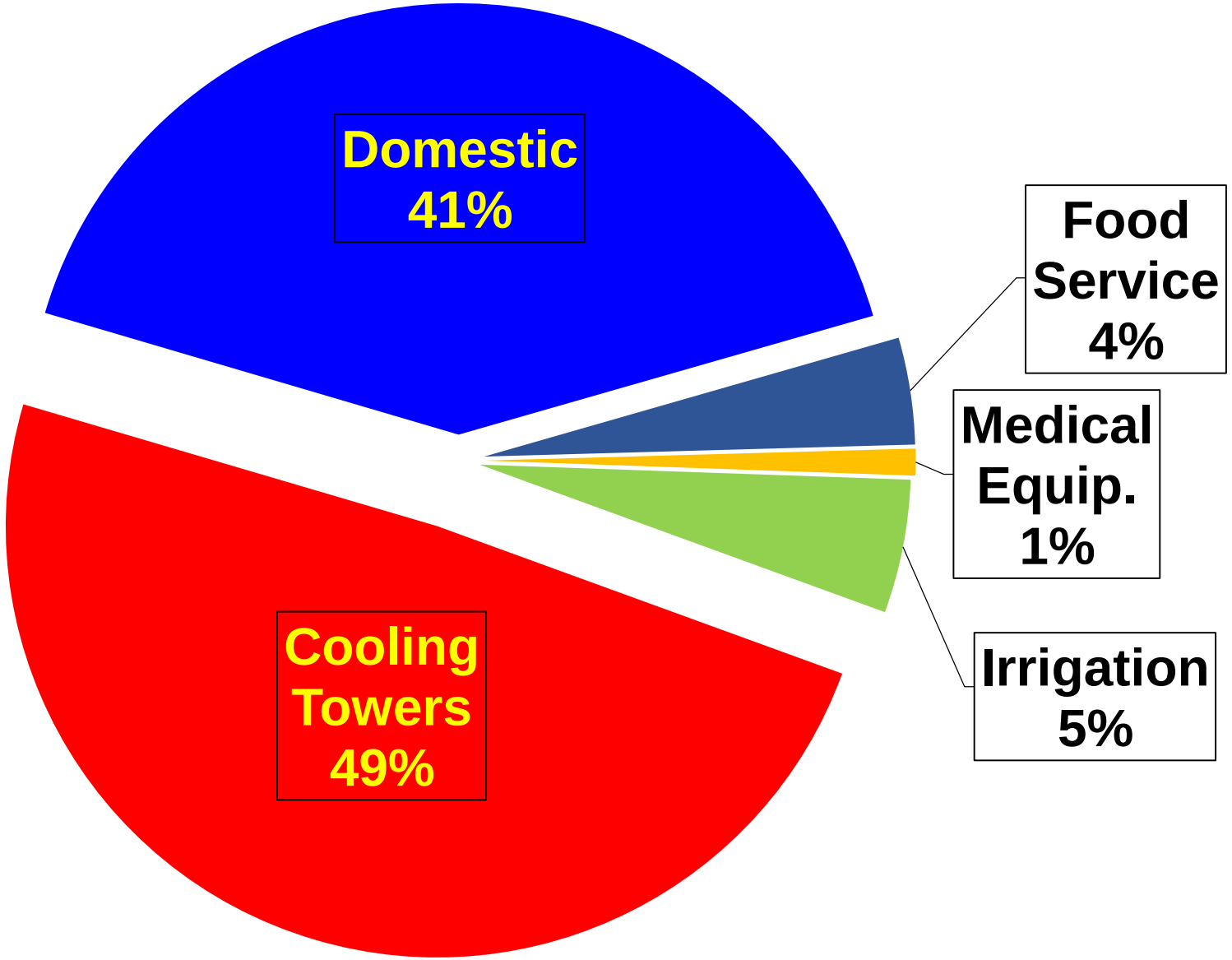
Water Management , Inc.



A Large Hospital in Florida

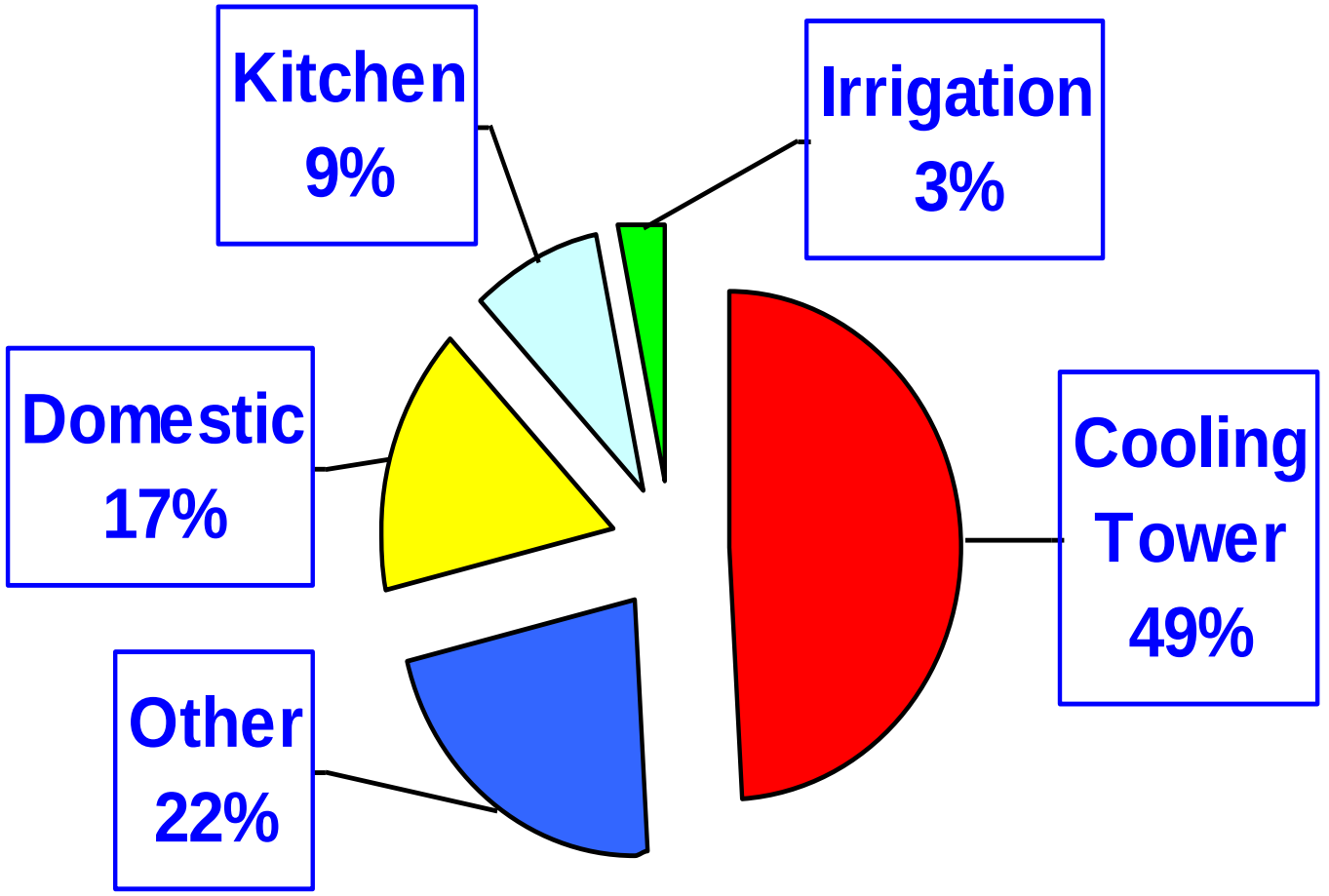


A Large Hospital in Arizona



Grocery Store Water Use in California

Pacific Institute



Cooling Towers

The purpose of a cooling tower is to get rid of

unwanted energy!

Rising Water & Sewer Rates From a National Perspective

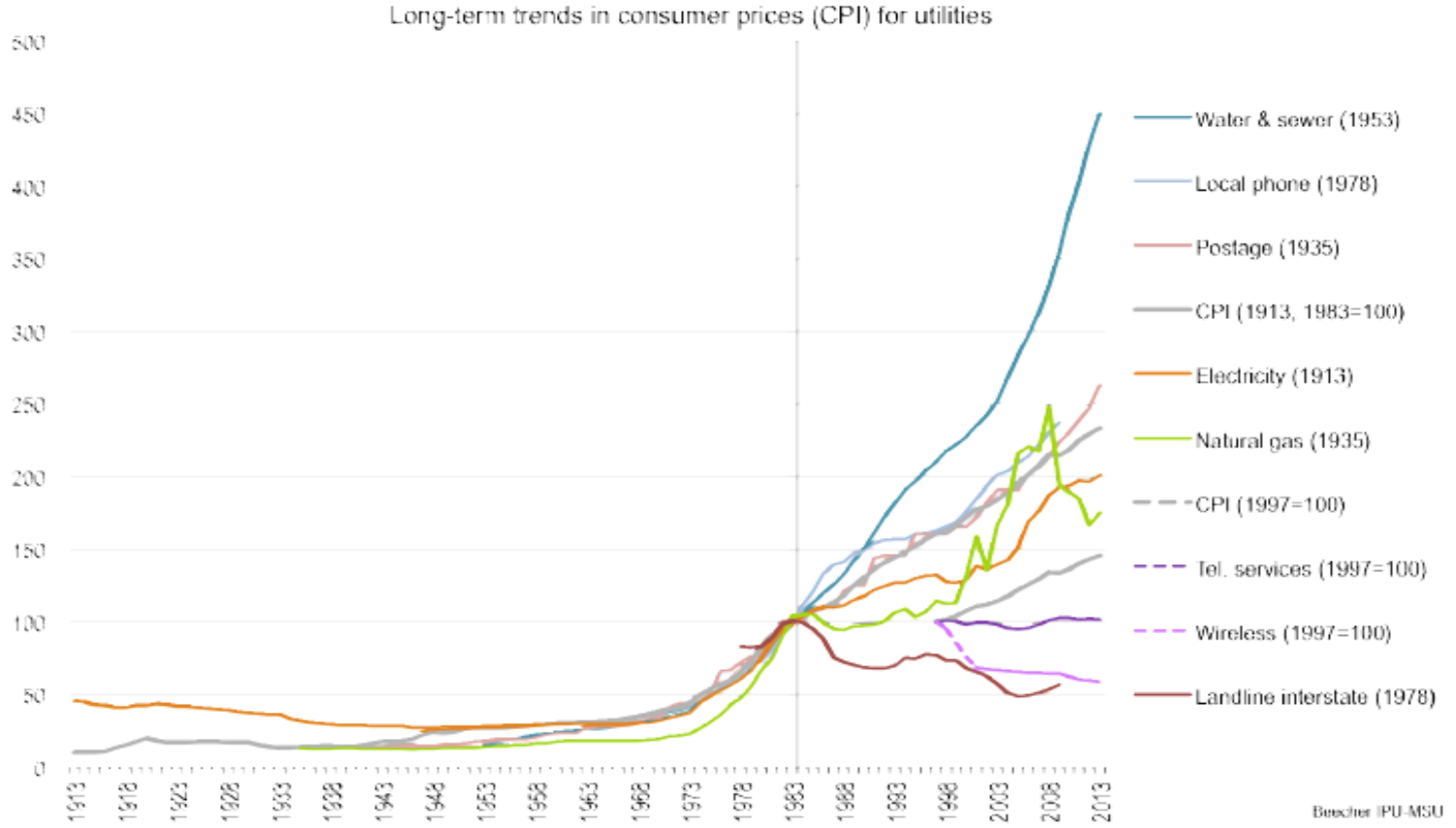
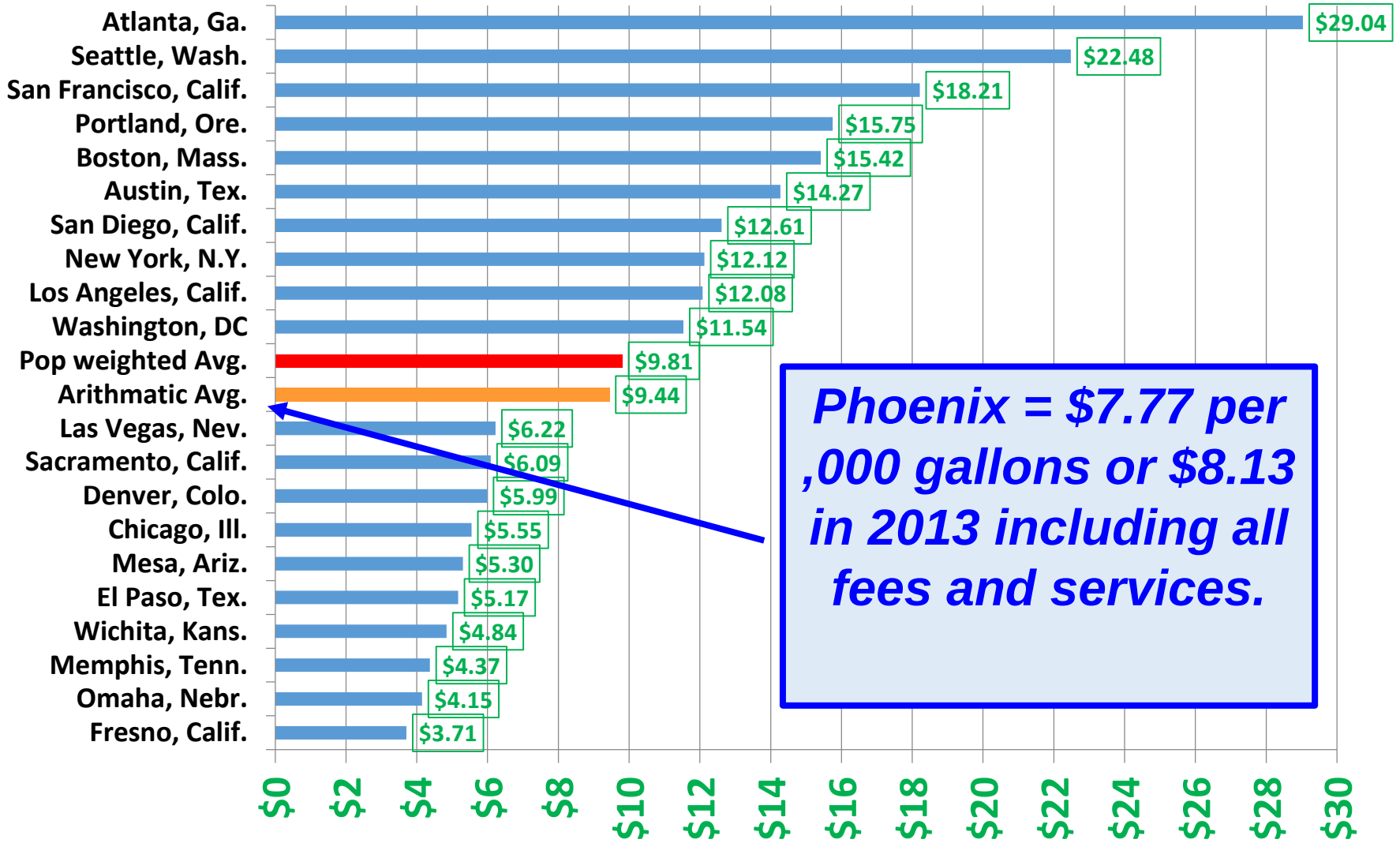


Exhibit 1. Long-term trends in the Consumer Price Index (CPI) for utilities (1913-2013). The index is set to 100 for 1982-1984 except for telephone and wireless services, where the index is set to 100 for 1997. Year (*) indicates start of series.

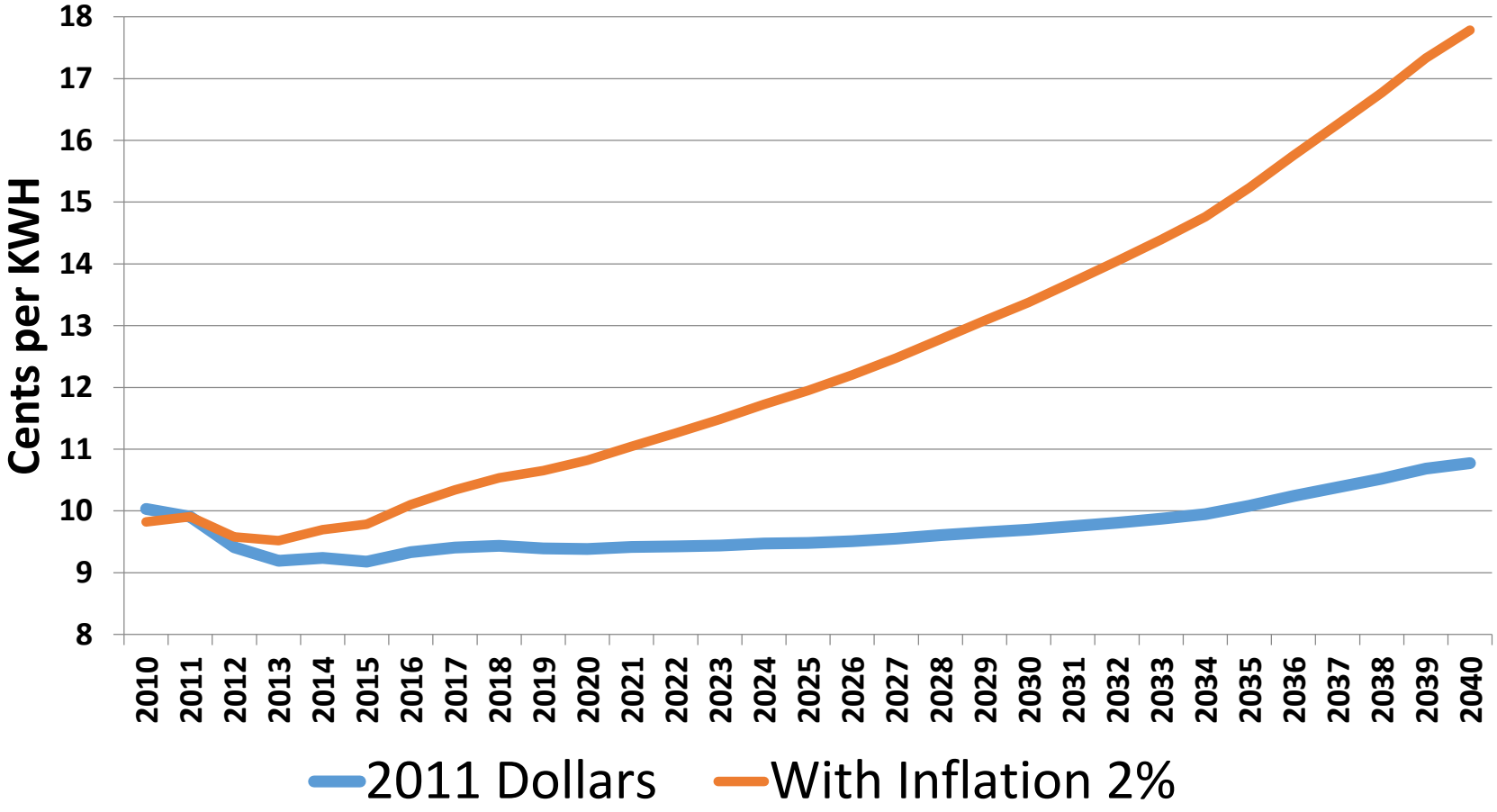
Commercial Combined Water and Sewer Rates For 50 Largest Cities in 2013

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

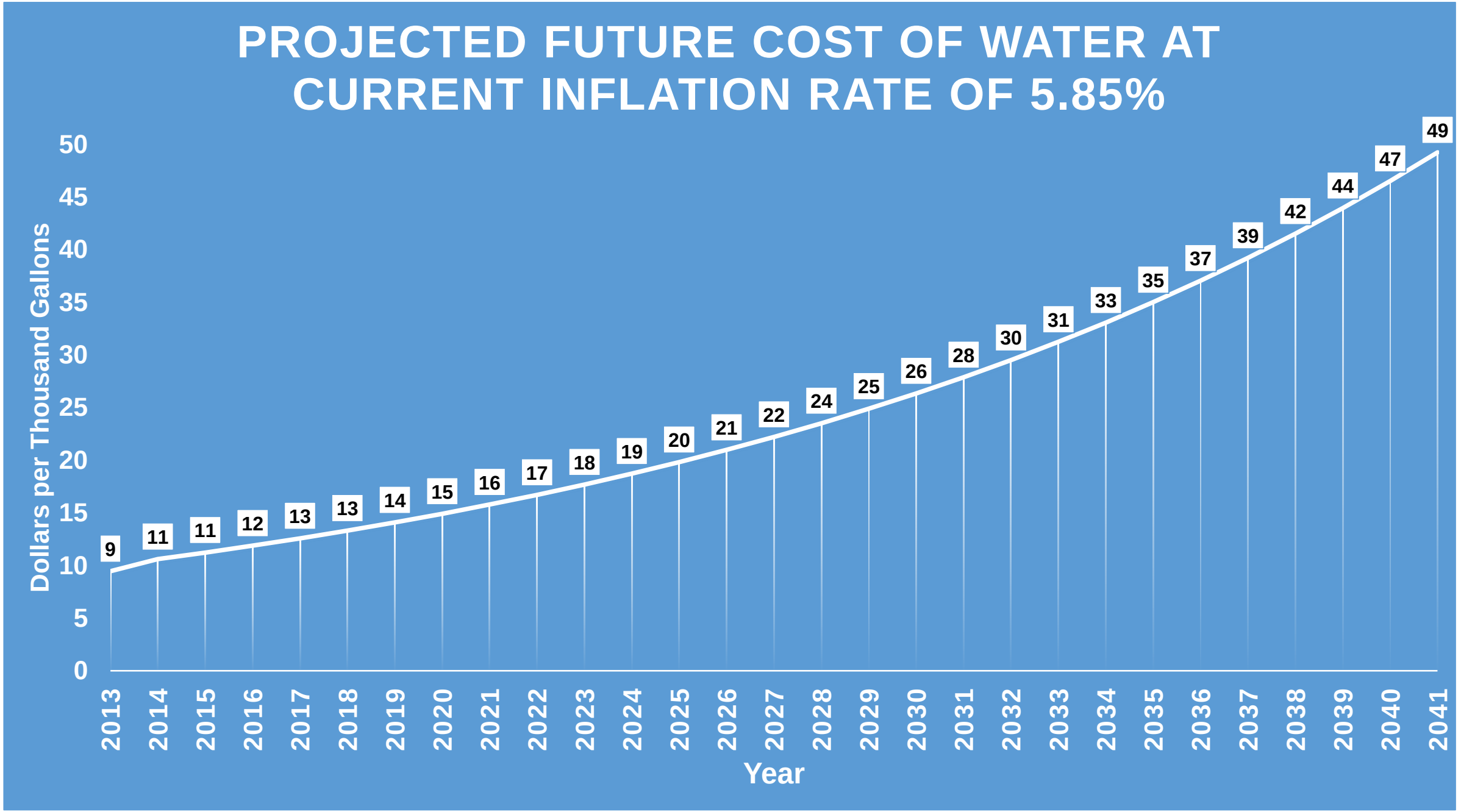


Cents per KWH

(With & Without Inflation)
Energy Information Administration



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



Savings With Cooling Tower

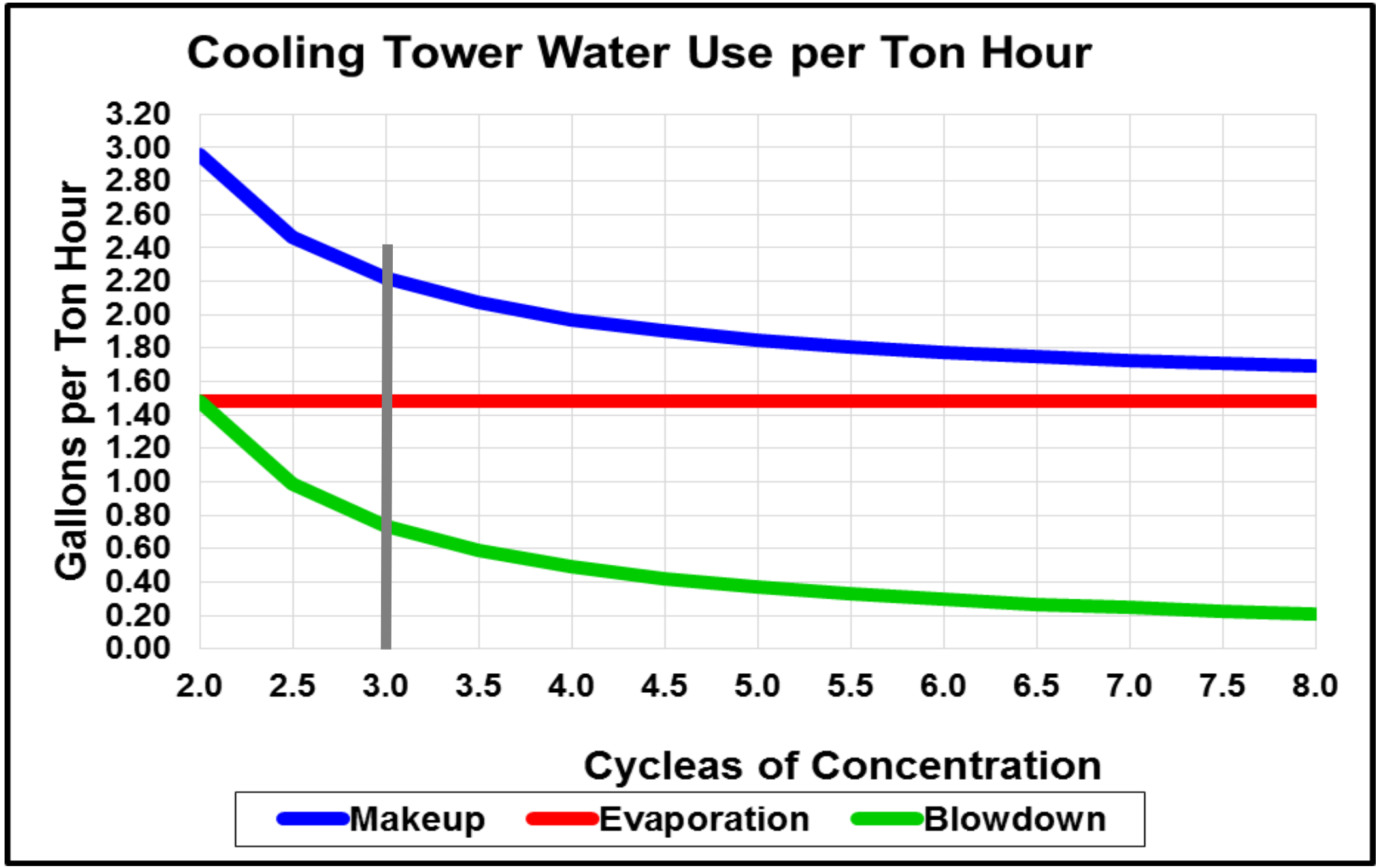
Energy savings

0.3 to 0.4 kWh/Ton-Hr

Equal to about

3.0 to 4.0 *cents*

in most markets


Cooling Tower Water Use per Ton Hour
Gallons per Ton Hour
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Cycleas of Concentration
Makeup
Evaporation
Blowdown

And again -

The True Cost of Water

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

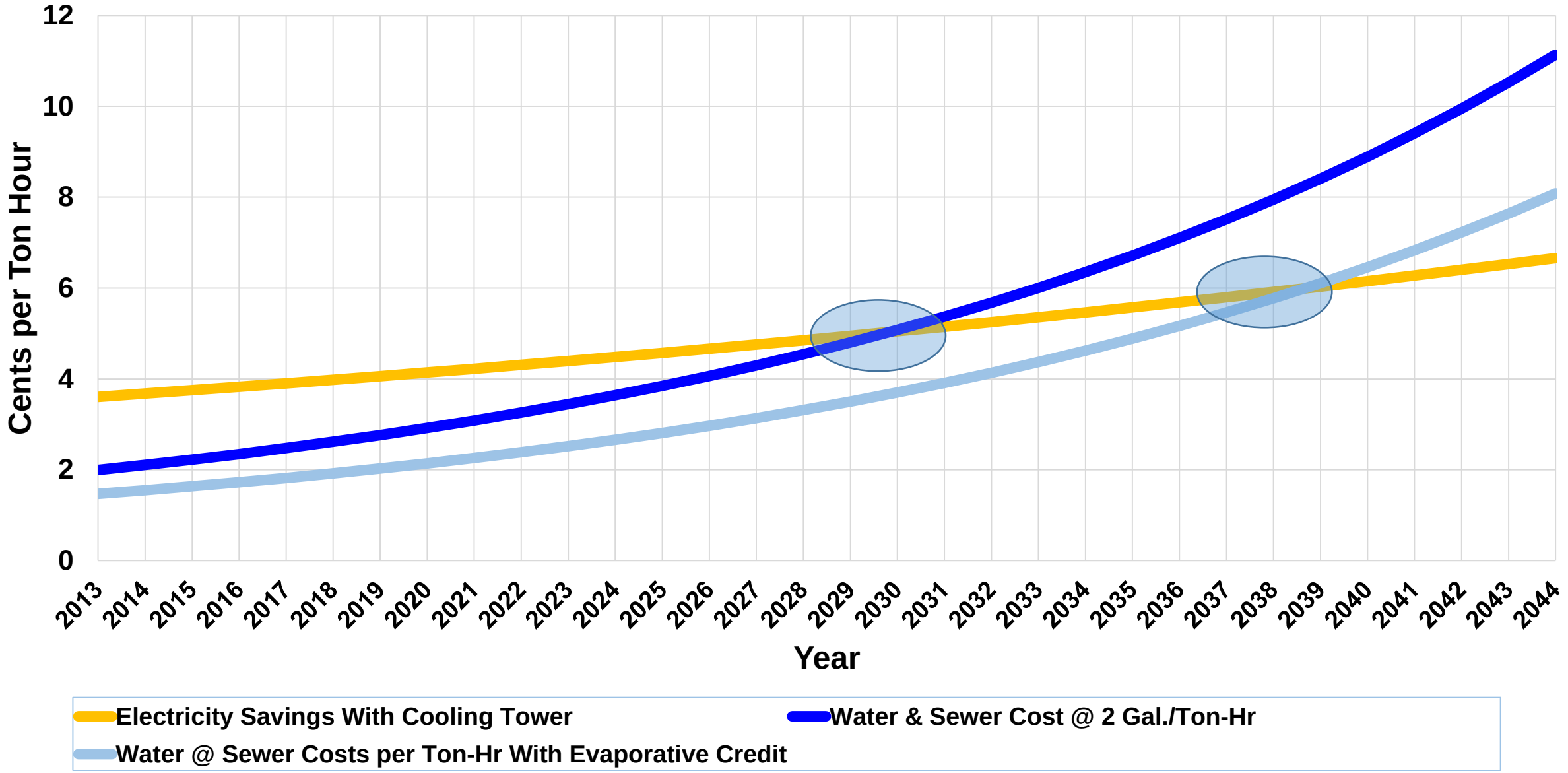
Additional Associated Cost of Tower Operations

Cost Factor	Cents per Ton Hour		
At 2.0 gal./Ton-hour	**lowest**	**Median**	**Highest**
Water Treatment (Chemical and other)	0.1	0.2	0.9
Labor & Other	0	0.1	0.1
TOTAL	**0.1**	**0.3**	**1.0**

In Austin, Texas, typical treatment cost are in the range of 0.4 to 0.5 cents per ton hour ($2.00 to $2.50 per thousand gallons)

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 and wastewater costs plus 0.1 cents per ton hou



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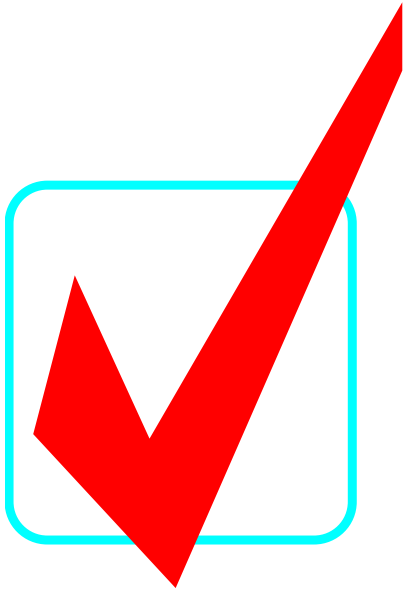

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