This presentation premiered at WaterSmart Innovations

watersmartinnovations.com

# The Status of Benchmarking ICI Water Use

Presented by

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at

*WaterSmart Innovations 2019*

# The Coming *Deluge* of Data
*How to make it work for us.*

- **Major new benchmarking efforts nation wide**
- **Energy Star Portfolio Manager**
- **Better Buildings Challenge**
- **2030 District Network**

- **AMI**
- **The IOT**
- **GIS**
- **Drones and Satellites**
- **????????????????**

# What Will Be Covered

- **Examinations of problems and shortcomings of current efforts**
  - The denominator dilemma;
  - Mean, medial, outliers;
  - We need more than just a number; and
  - Where to get denominator information.

- **A quick review current and past benchmarking efforts both in the USA and abroad**

- **Uses of benchmarking data can serve many purposes**
  - Analysis of benchmark data can help direct programs;
  - The data identifies potential problem facilities;
  - Benchmarking can help examine effectiveness of conservation efforts; and
  - The data can help in making projections of future water use and potential water savings.

- **The future of benchmarking in a very data rich future environment:**
  - The data-verse, and
  - Known and unknown unknowns.

# What is Benchmarking?

- **Benchmarking is comparing one's business processes and <u>performance metrics</u> to industry bests and <u>best practices</u> from other companies.** *(From Wikipedia)*

- **For water, this means dividing water use *(Numerator)* by some *meaningful???* measure of the facility *(Denominator)* and then comparing that to other establishments of the same type.**

- **Welcome to the *Denominator Dilemma!***

# Examples of Possible Denominators

| Facility Type | Function Metric | Facility Metric | Other People Metrics |
|---|---|---|---|
| Hotel | Guests | Rooms, Square Feet | Employees |
| Hospital | Patients, Discharges, Out-Patients, Patient Nights | Beds, Occupied Beds, Square Feet | Employees |
| Clinics | Patients, Procedures | Chairs (dental) Square Feet | Employees |
| School | Students | Square Feet | Faculty, Staff |
| Restaurant | Meals Served, Covers, Tickets | Number of Seats, Square Feet | Employees |
| Office | Employees, Visitors | Square Feet | |
| Retirement Home | Residents | Rooms, Beds, Square Feet | Employees |
| Commercial Laundries | Pounds of Laundry | Washer Capacity, Square Feet | Employees |
| Multi-Family | Number of Residents | Dwelling Units, Square Feet | Bedrooms |
| Automotive Shop | Vehicles Serviced | Square Feet, Number of Bays | Employees |
| Manufacturing | Units of Product Produced, Dollars Produced | Square Feet, Number of Pieces of Equipment | Employees |
| Retail | Customers, Number of Transactions | Square Feet | Employees |
| Grocery | Customers, Number of Transactions | Square Feet | Employees |

# And then it gets crazy!

- **Time  - day week, month, year, work days, student days**

- **Employee and Student Facility Use - full time equivalents, weighted campus users**

- **Square Feet – total, heated, indoor, cooled**

- **Employees – full time, part time, employee hours**

- **Live in facilities – occupied days, total occupants, number of beds, etc.**

- **Lodging – Occupied rooms, total rooms, number of occupants**

# Other report examples

- Acre feet per student per year

- Thousand of gallons per bed pre year

- Gallons per thousand square feet per year

- Might as well be **cubic furlongs per fortnight per square cubit!**

# Review of Current and Past Commercial and Institutional Benchmarking Efforts

- **Energy Star Portfolio Manager**

- **DOE – Commercial Buildings Energy Consumptions Survey**

- **Water Research Foundations**

- **Municipal Studies**

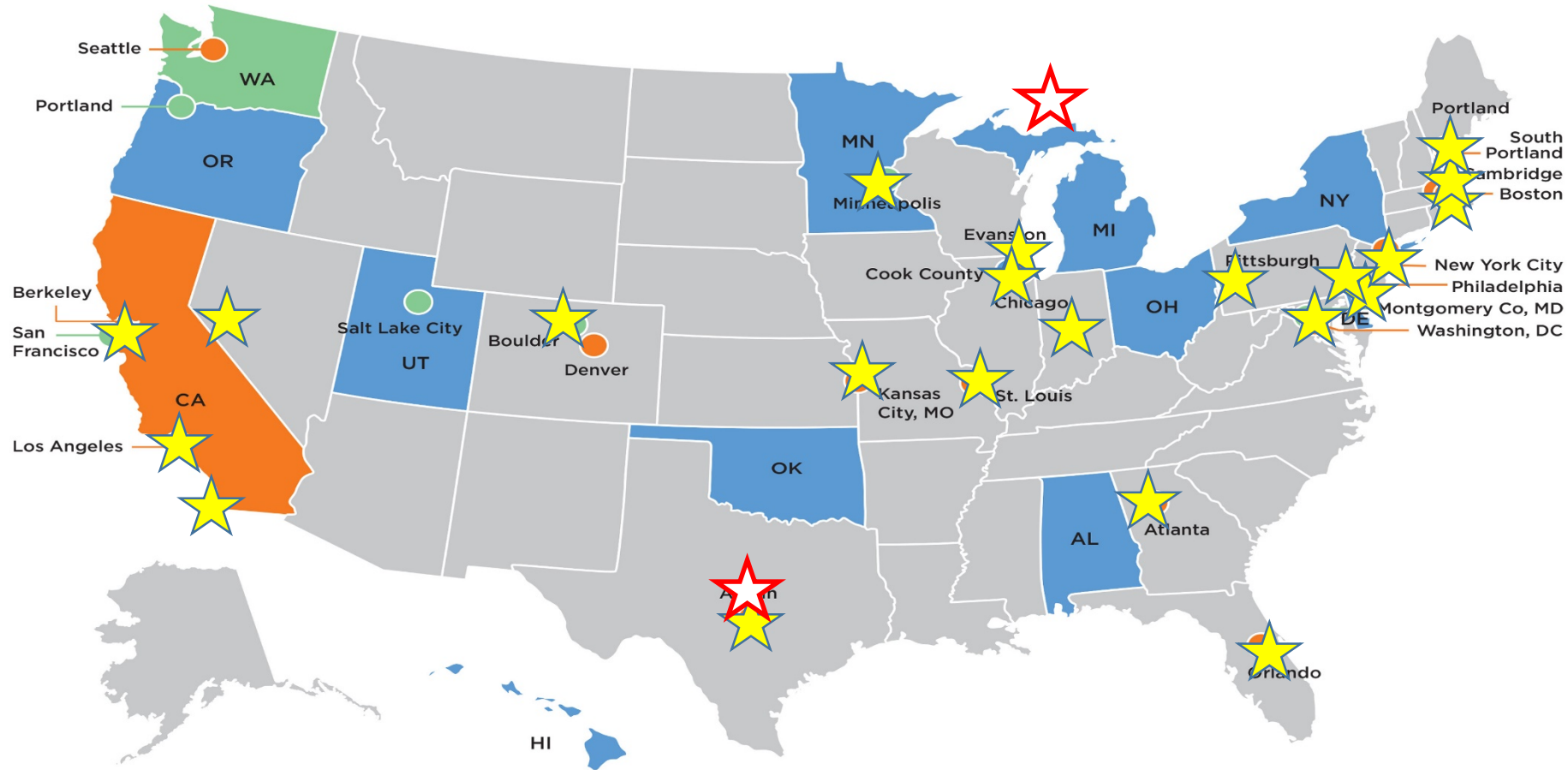- **Academic Studies and Efforts**

- **State Efforts**

# Commercial and Institutional Benchmarking
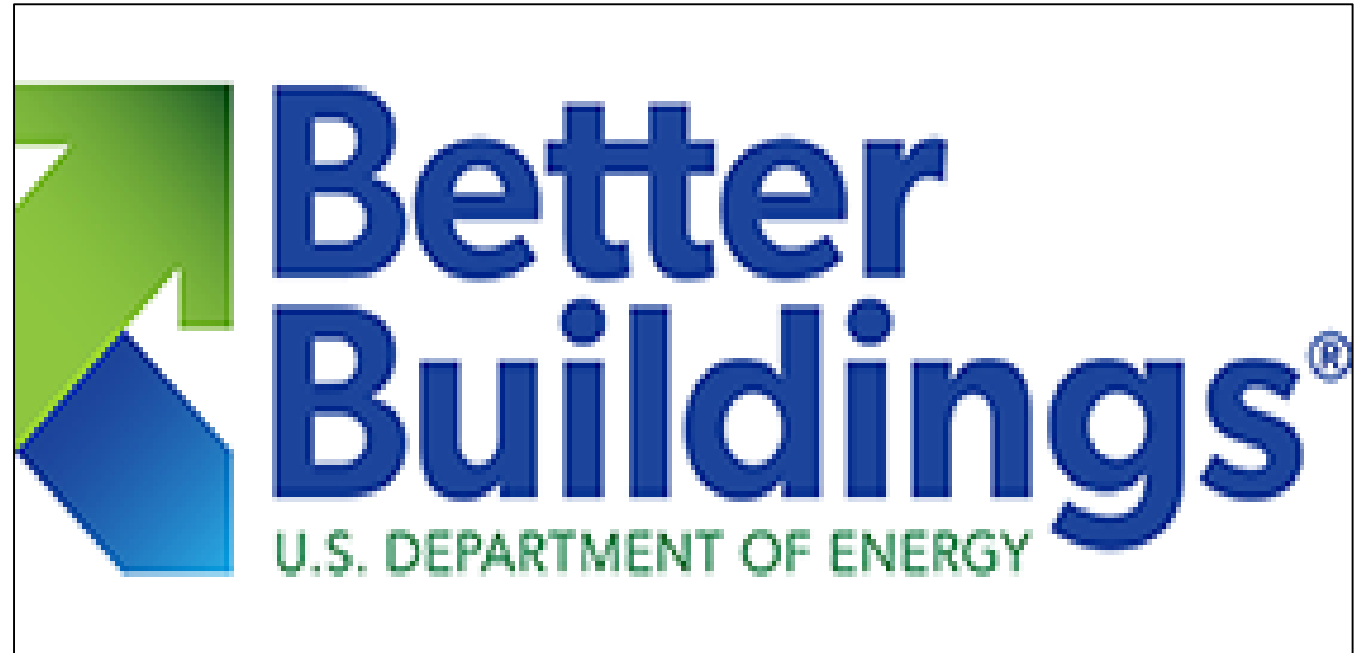
# Energy Star Portfolio Manager

- Developed for Energy Benchmarking, but now includes a Water Tool

- Many cities are using this in their required energy and water benchmarking efforts.

# Locations with Water Benchmarking



U.S. Building Benchmarking and Transparency Policies

Seattle
Portland
WA
OR
Berkeley
San Francisco
CA
Los Angeles
Salt Lake City
UT
Boulder
Denver
OK
MN
Minneapolis
Evanston
Cook County
Chicago
MI
OH
Kansas City, MO
St. Louis
AL
Atlanta
Austin
Orlando
HI

NY
Portland
South Portland
Cambridge
Boston
Pittsburgh
New York City
Philadelphia
DE
Montgomery Co, MD
Washington, DC

● Public, commercial, and multifamily building benchmarking policy adopted

● Public and commercial building benchmarking policy adopted

● Public buildings benchmarked

Building Rating
SHARING TRANSPARENCY FOR A MORE EFFICIENT FUTURE

IMT
INSTITUTE FOR MARKET TRANSFORMATION

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# National Initiatives

# Examples of Energy Star Portfolio Manager Data for Office Buildings

**Gallons per Square Foot per Year**

| City | New York | Washington DC | Boston | Minneapolis |
|---|---|---|---|---|
| **No. of Buildings** | (398) | (342) | (218) | (80) |
| **Low (Meter stuck??)** | 0.01 | 0.2 | 0.09 | 0.01 |
| **Median** | 16.7 | 16.1 | 11.6 | 10.8 |
| **Average** | 45.6 | 163.7 | 40.7 | 12.1 |
| **High (Yikes!!)** | 4,821.5 | 33,917.8 | 1,552.3 | 43.6 |

# EPA Portfolio Manager Information on Water



Office Use Per Worker

Portfolio Manager Median = 13 gal/worker/day

95th percentile = 85
5th percentile = 2

Y-axis: Number of Buildings (0, 200, 400, 600, 800, 1,000, 1,200)
X-axis: Gallons per Worker per Day (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100+)

Hotel Use Per Room

Portfolio Manager Median = 102 gal/room/day

95th percentile = 320
5th percentile = 23

Y-axis: Number of Buildings (0, 10, 20, 30, 40, 50, 60, 70, 80)
X-axis: Gallons per Room per Day (0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600+)

Hospital Use Per Bed

Portfolio Manager Median = 315 gal/bed/day

95th percentile = 1,061
5th percentile = 43

Y-axis: Number of Buildings (0, 10, 20, 30, 40, 50)
X-axis: Gallons per Bed per Day (0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500+)
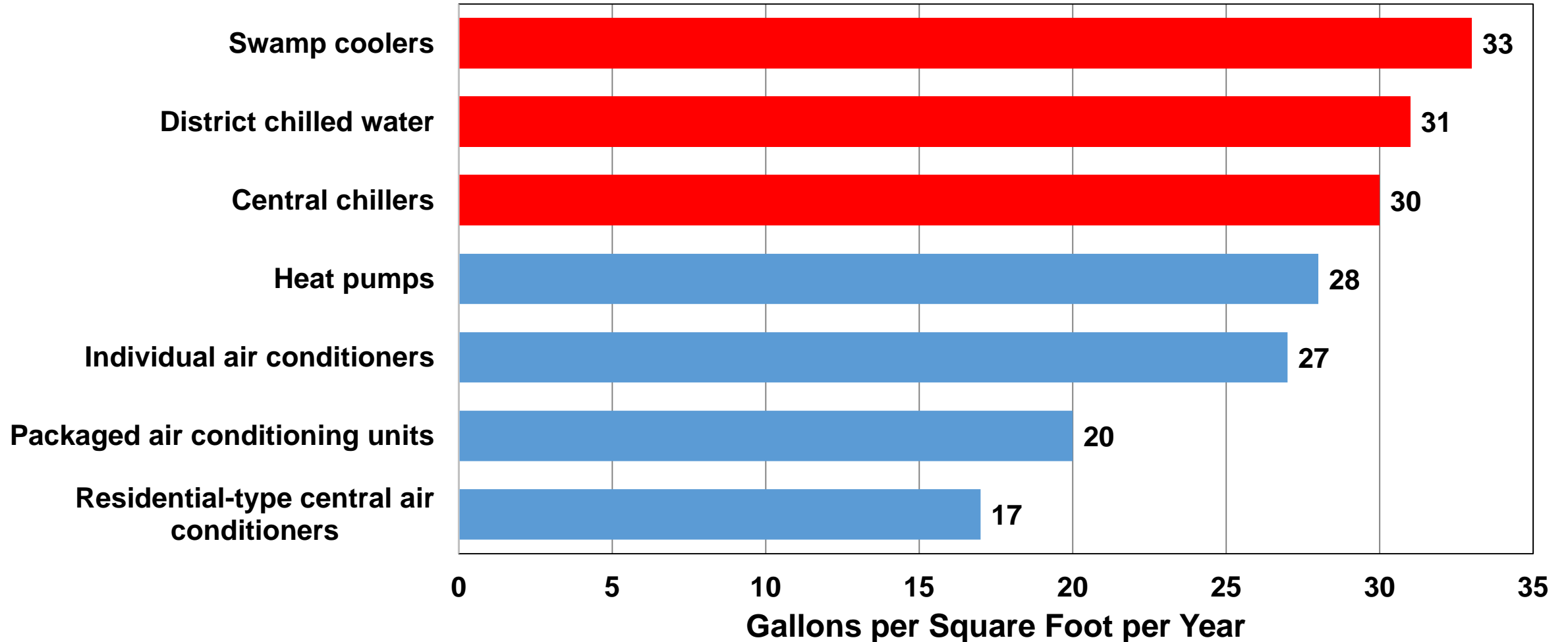
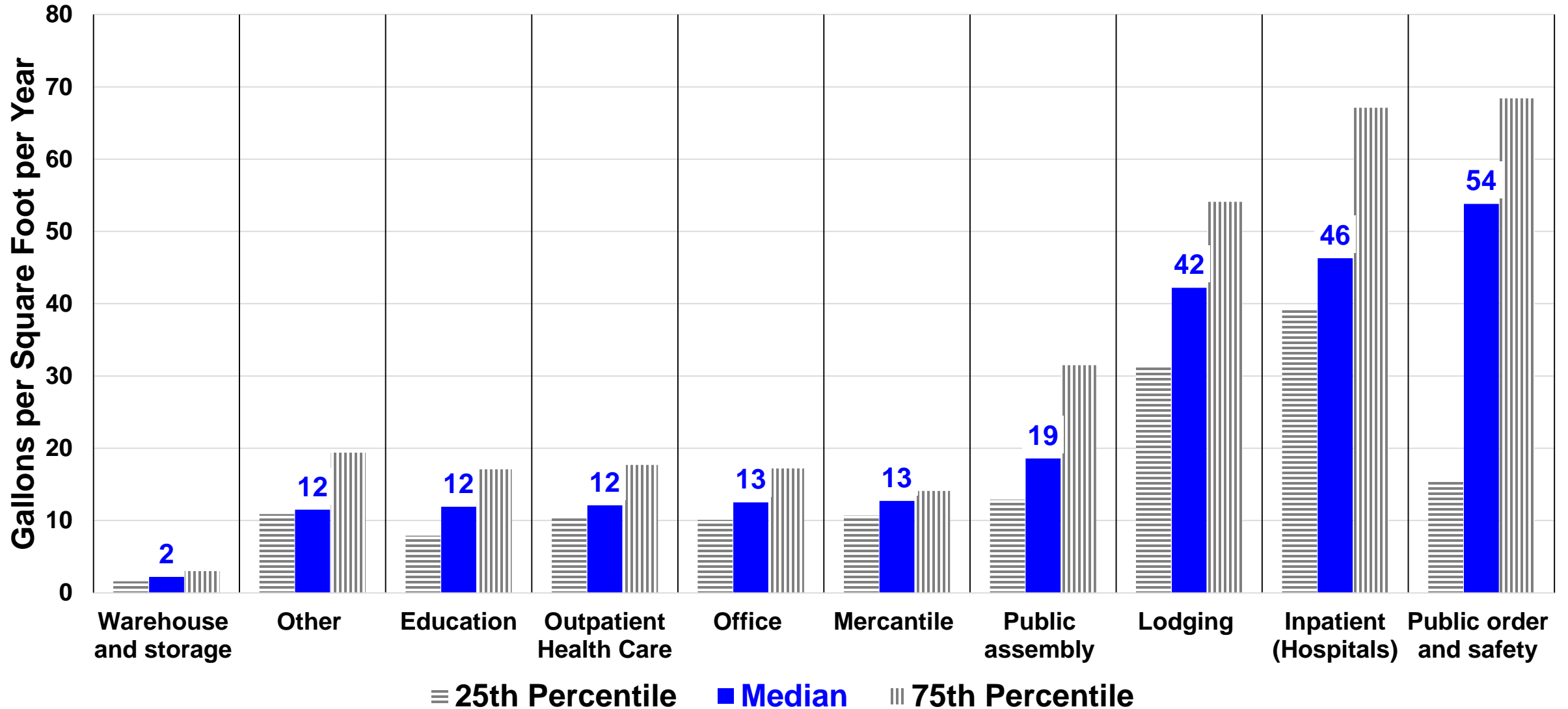# Commercial Building Energy Consumption Survey
## CBECS

- In 2018 reported water use for building greater than 200,000 square feet for 2012

- Hospital water use was done as an example in 2003

- Next survey year will be 2018 and will be available around 2022

- The first seven surveys only addressed energy use

*The USA has 5.6 million CI buildings and 87 billion square feet of floor space*
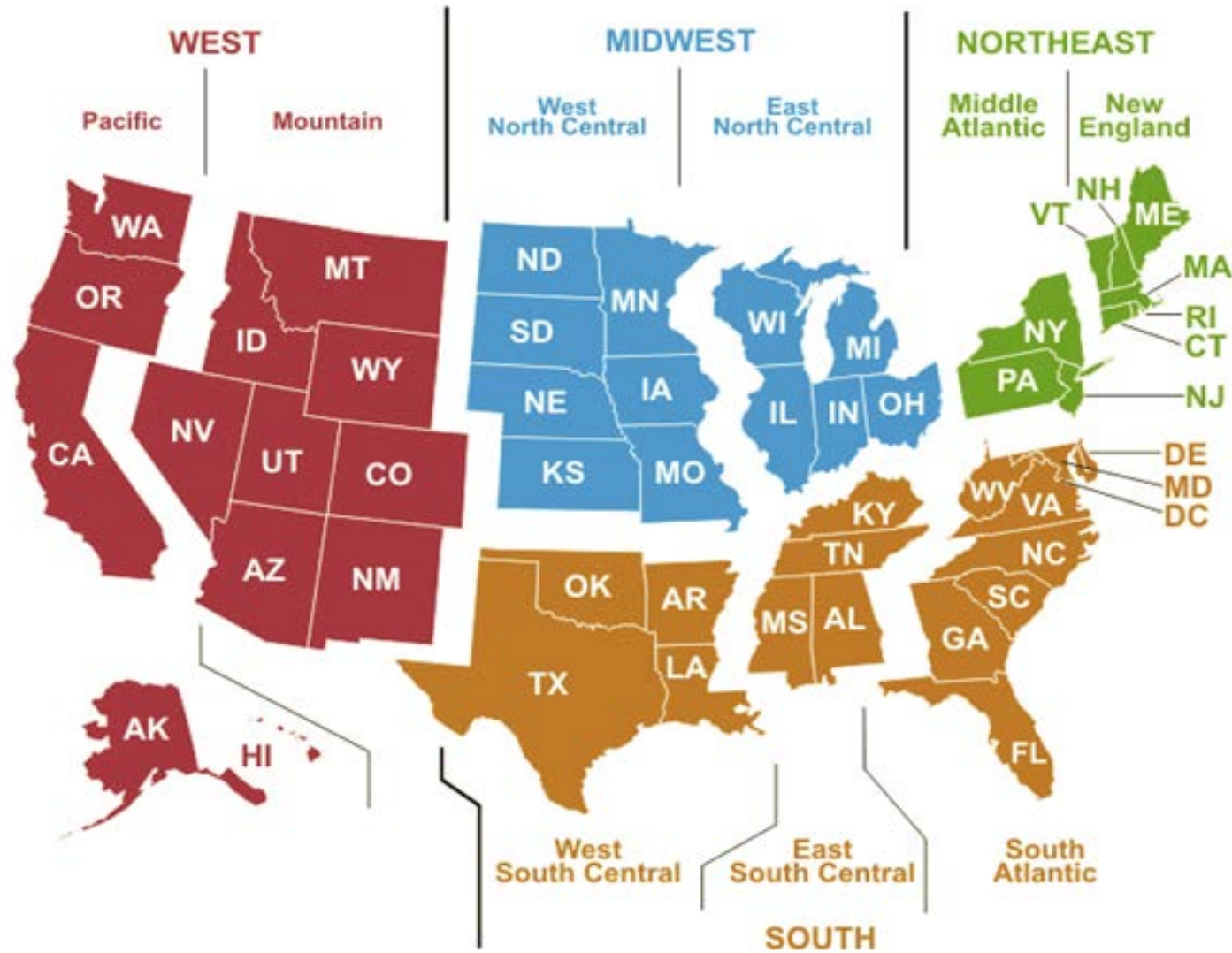
# Gallons of Water per Square Foot per Year
## for Very Large (Greater than 200,000 sq. ft.) Buildings by Type
## of Cooling Equipment

| Type of Cooling Equipment | Gallons per Square Foot per Year |
|---|---|
| Swamp coolers | 33 |
| District chilled water | 31 |
| Central chillers | 30 |
| Heat pumps | 28 |
| Individual air conditioners | 27 |
| Packaged air conditioning units | 20 |
| Residential-type central air conditioners | 17 |

Gallons per Square Foot per Year

**Comparison of Gallons of Water Used per Square Foot per Year for Buildings with More than 200,000 Square Feet from CBECS**

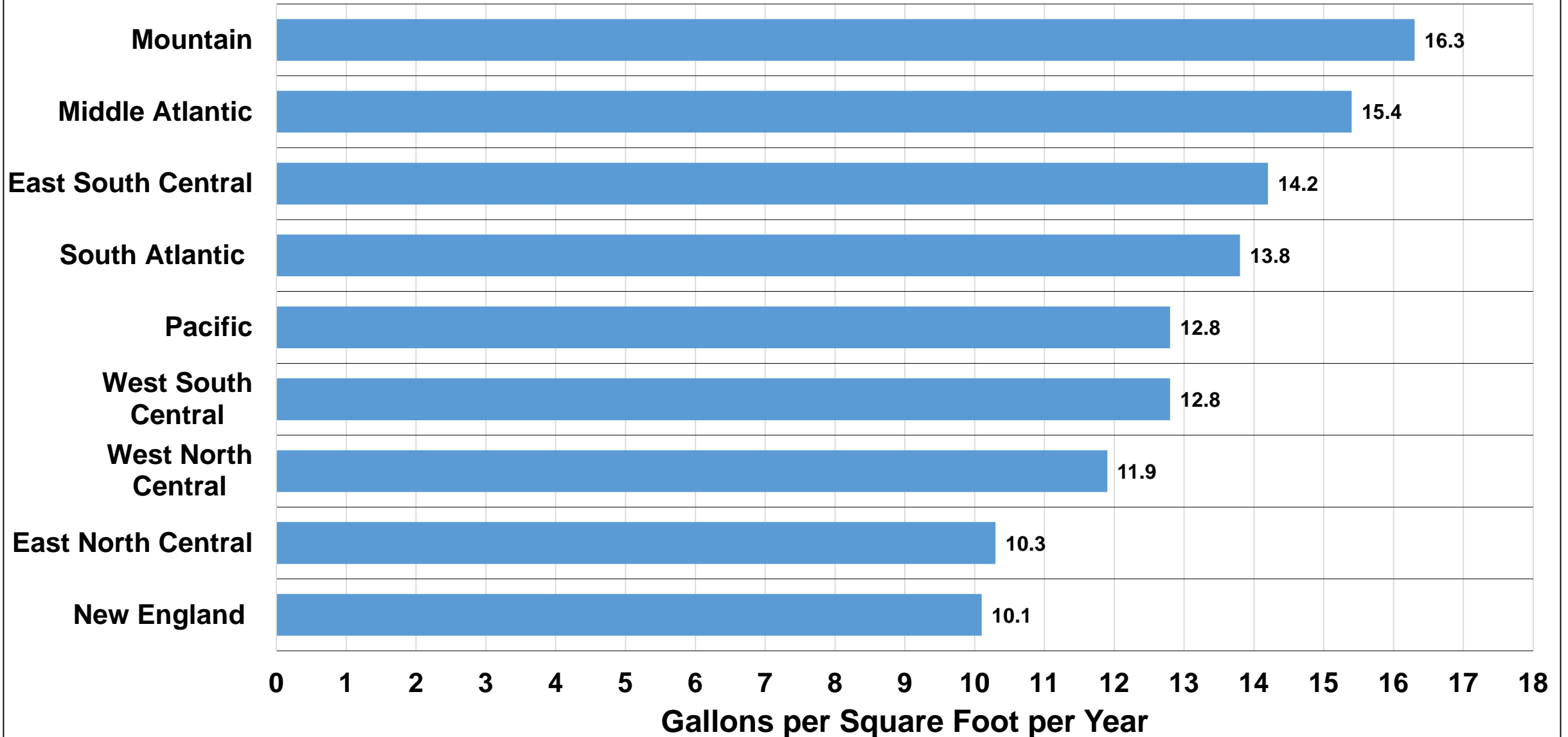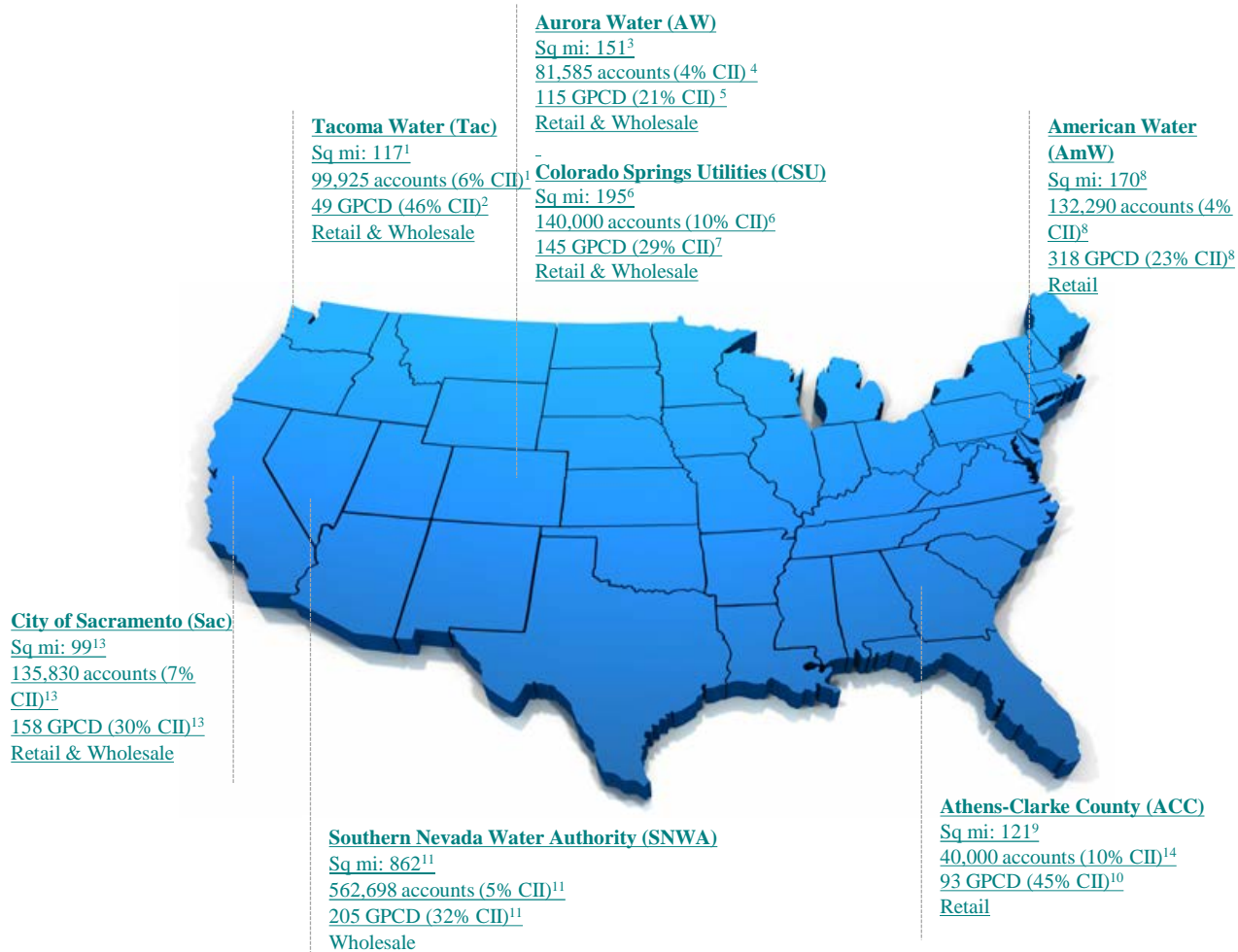Gallons per Square Foot per Year

| Category | Median |
|---|---|
| Warehouse and storage | 2 |
| Other | 12 |
| Education | 12 |
| Outpatient Health Care | 12 |
| Office | 13 |
| Mercantile | 13 |
| Public assembly | 19 |
| Lodging | 42 |
| Inpatient (Hospitals) | 46 |
| Public order and safety | 54 |

≡ 25th Percentile ▮ Median ⦀ 75th Percentile

# Census Regions Used by CBECS



https://www.eia.gov/consumption/commercial/maps.php

Gallons of Water per Square Foot per Year
for Very Large (Greater than 200,000 sq. ft.) Buildings by Census Region

| Census Region | Gallons per Square Foot per Year |
|---|---|
| Mountain | 16.3 |
| Middle Atlantic | 15.4 |
| East South Central | 14.2 |
| South Atlantic | 13.8 |
| Pacific | 12.8 |
| West South Central | 12.8 |
| West North Central | 11.9 |
| East North Central | 10.3 |
| New England | 10.1 |

# Water Research Foundation Benchmarking Efforts

- **Methodology for Evaluating Water Use in the Commercial, Institutional, and Industrial Sectors – Report # 4375**

- **Water Use in the Multi-Family Housing Sector – Report # 4554**

- **Developing Water Use Metrics in the Commercial, Industrial, and Institutional Sectors – Report # 4619**
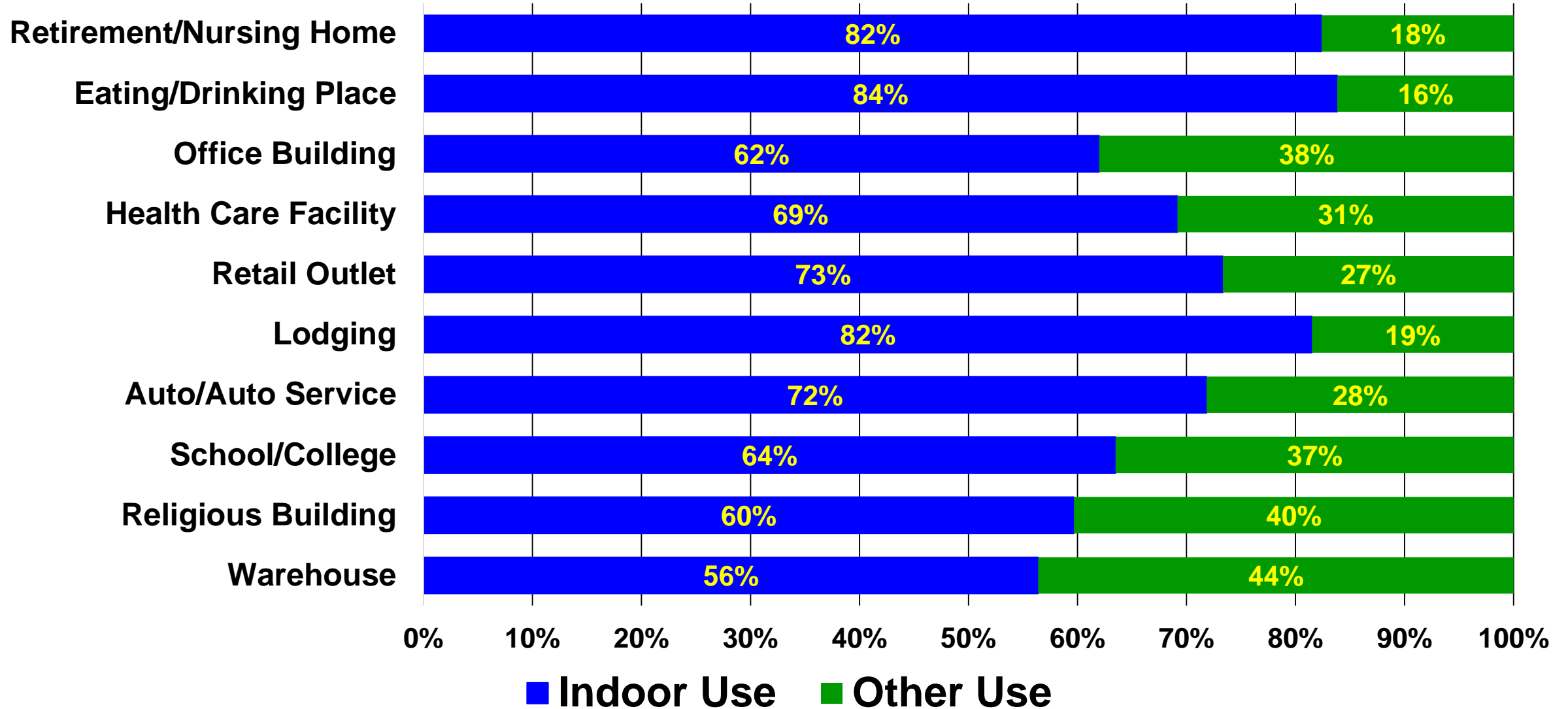
# WRF report 4619 Map

**Aurora Water (AW)**
Sq mi: 151[3]
81,585 accounts (4% CII) [4]
115 GPCD (21% CII) [5]
Retail & Wholesale

**Tacoma Water (Tac)**
Sq mi: 117[1]
99,925 accounts (6% CII)[1]
49 GPCD (46% CII)[2]
Retail & Wholesale

**Colorado Springs Utilities (CSU)**
Sq mi: 195[6]
140,000 accounts (10% CII)[6]
145 GPCD (29% CII)[7]
Retail & Wholesale

**American Water (AmW)**
Sq mi: 170[8]
132,290 accounts (4% CII)[8]
318 GPCD (23% CII)[8]
Retail

**City of Sacramento (Sac)**
Sq mi: 99[13]
135,830 accounts (7% CII)[13]
158 GPCD (30% CII)[13]
Retail & Wholesale

**Southern Nevada Water Authority (SNWA)**
Sq mi: 862[11]
562,698 accounts (5% CII)[11]
205 GPCD (32% CII)[11]
Wholesale

**Athens-Clarke County (ACC)**
Sq mi: 121[9]
40,000 accounts (10% CII)[14]
93 GPCD (45% CII)[10]
Retail

- **Sacramento California**
- **Tacoma Washington**
- **Southern Nevada Water Auth.**
- **Athens Clark County Georgia**
- **American Water New Jersey**
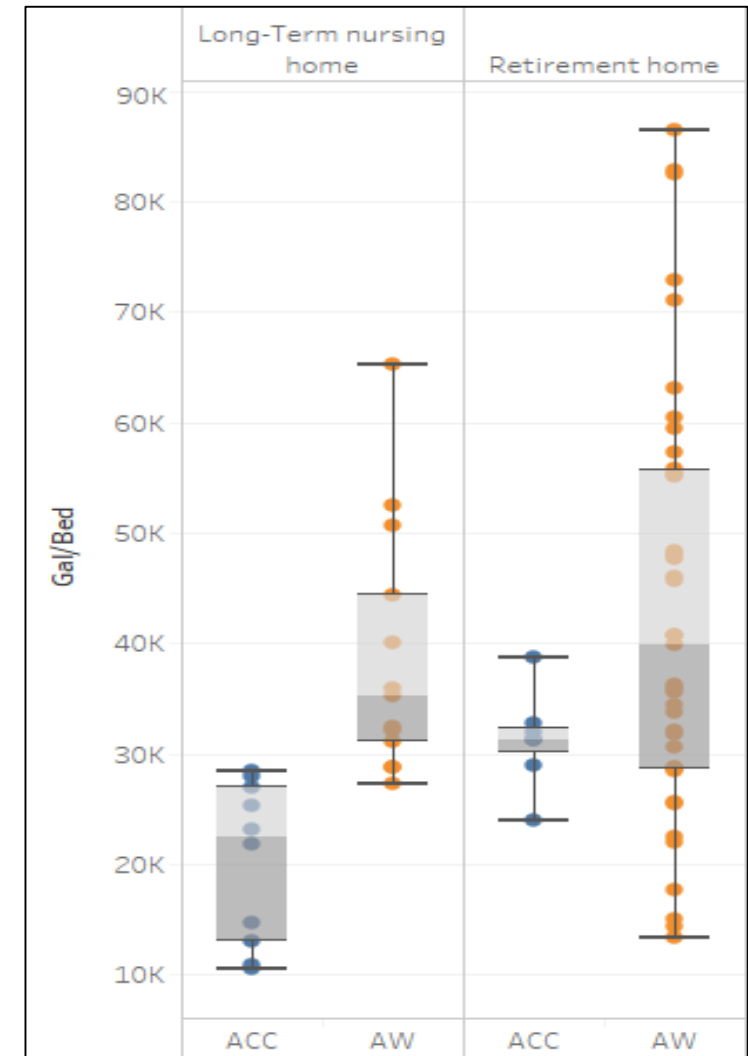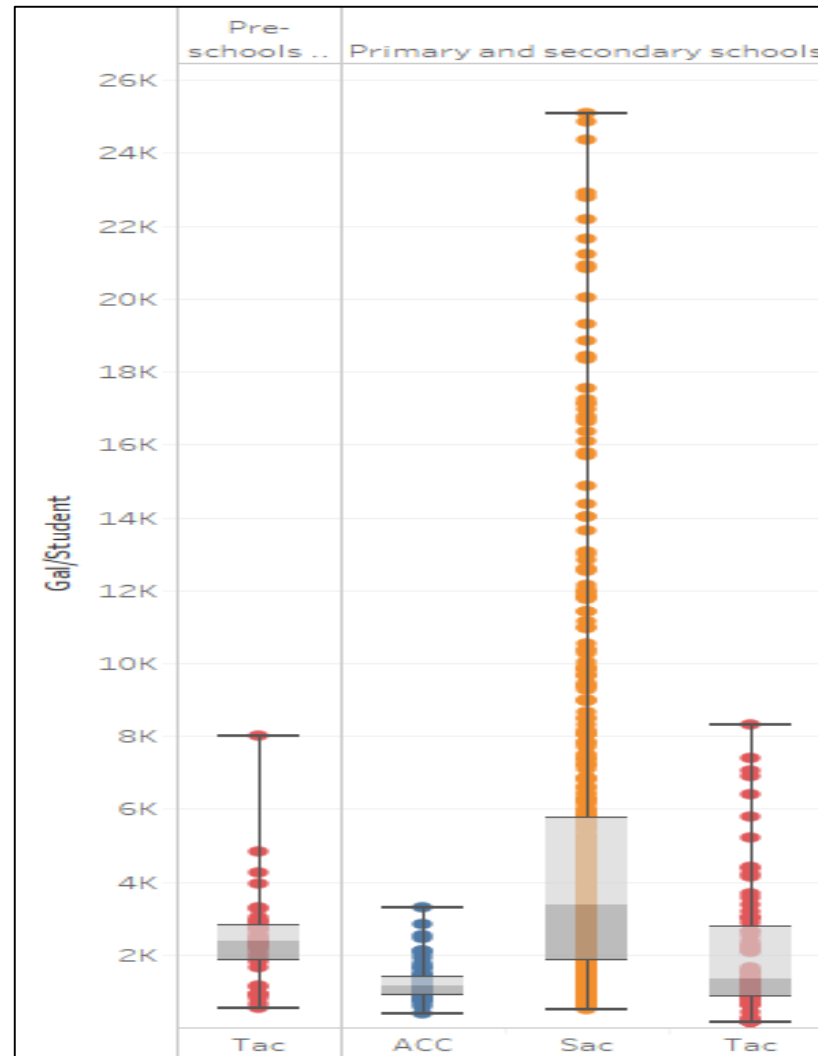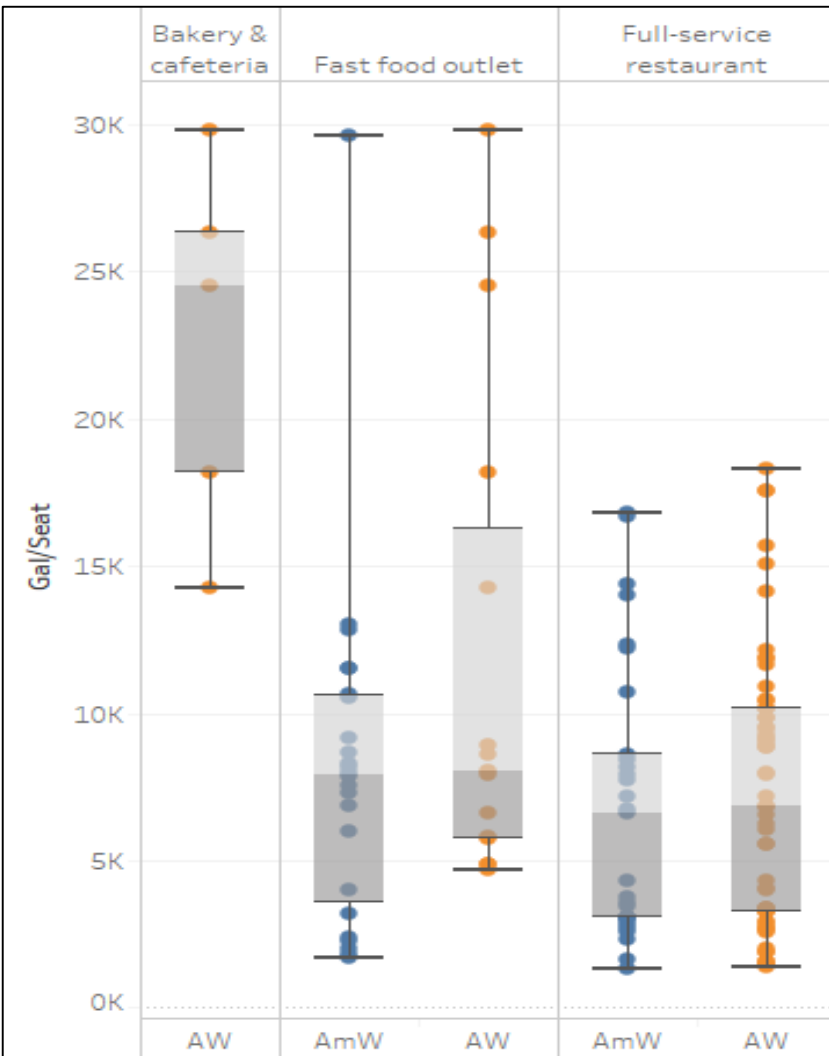- **Aurora Water Colorado**
- **Colorado Springs Colorado**

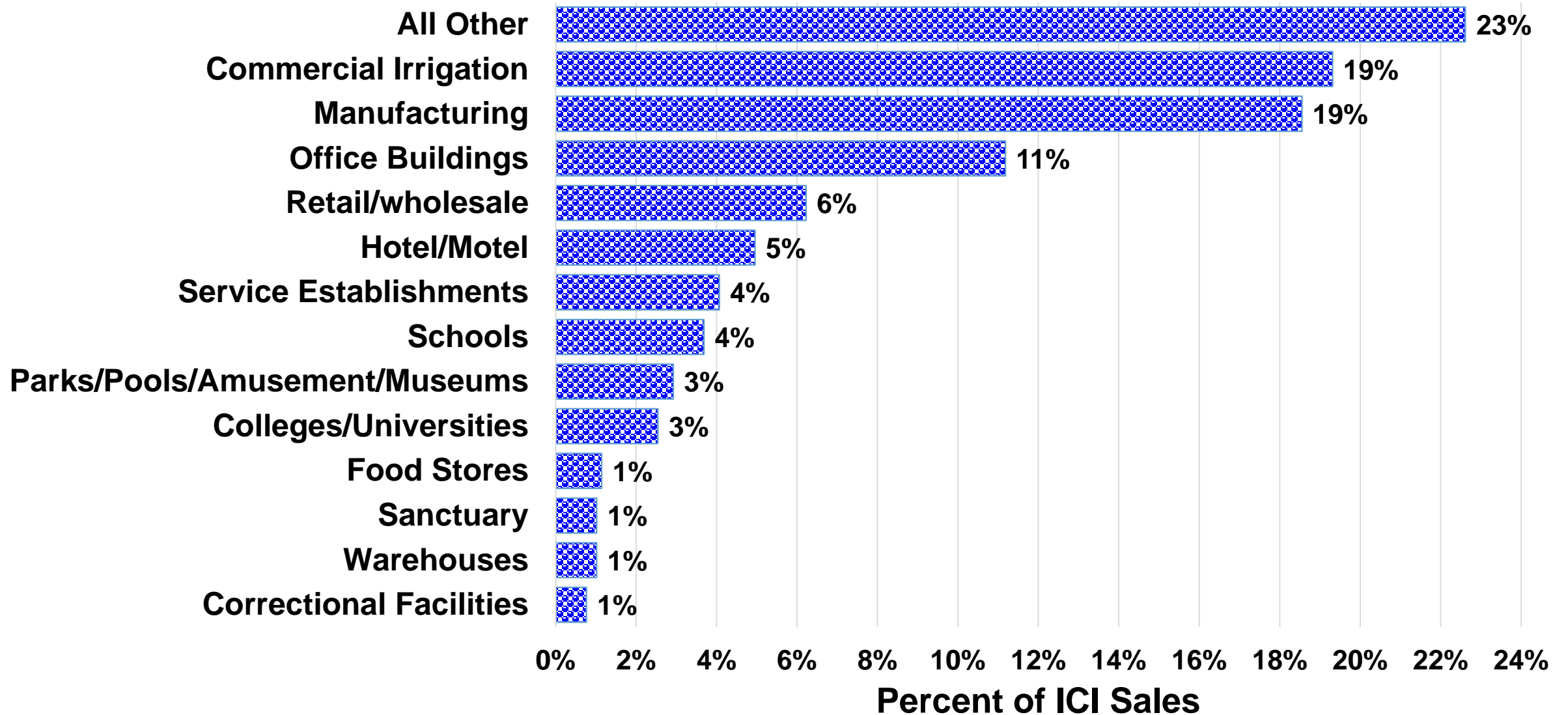# Indoor Use vs Other Uses

*Source: WRF 3 4619*



| Category | Indoor Use | Other Use |
|---|---|---|
| Retirement/Nursing Home | 82% | 18% |
| Eating/Drinking Place | 84% | 16% |
| Office Building | 62% | 38% |
| Health Care Facility | 69% | 31% |
| Retail Outlet | 73% | 27% |
| Lodging | 82% | 19% |
| Auto/Auto Service | 72% | 28% |
| School/College | 64% | 37% |
| Religious Building | 60% | 40% |
| Warehouse | 56% | 44% |

■ Indoor Use  ■ Other Use

# Examples of Regional Differences WRF # 4619
## Note that these are *annual* use numbers

# ICI Water Sales in Austin Texas

**Example Information in WRF 4375**

| Category | Percent |
|---|---|
| All Other | 23% |
| Commercial Irrigation | 19% |
| Manufacturing | 19% |
| Office Buildings | 11% |
| Retail/wholesale | 6% |
| Hotel/Motel | 5% |
| Service Establishments | 4% |
| Schools | 4% |
| Parks/Pools/Amusement/Museums | 3% |
| Colleges/Universities | 3% |
| Food Stores | 1% |
| Sanctuary | 1% |
| Warehouses | 1% |
| Correctional Facilities | 1% |

**Percent of ICI Sales**

# Samples of Histograms in WRF # 4375



Tampa Bay Water Restaurant Sample
Annual Water Use per Seat per Day
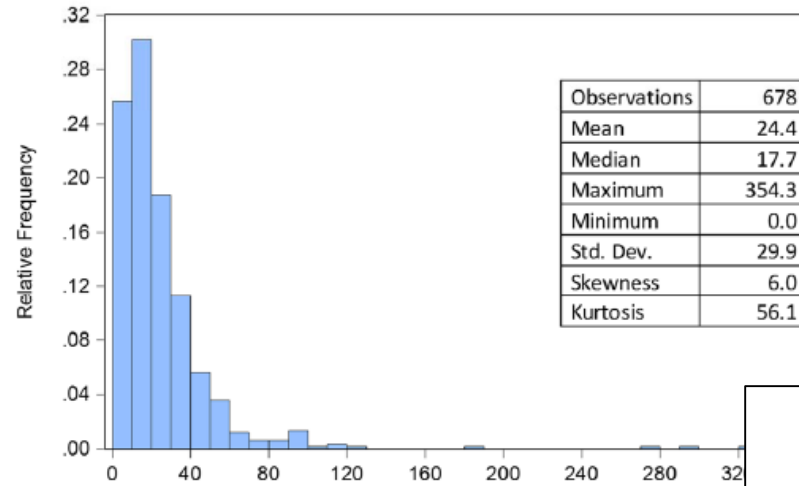
| Observations | 678 |
|---|---|
| Mean | 24.4 |
| Median | 17.7 |
| Maximum | 354.3 |
| Minimum | 0.0 |
| Std. Dev. | 29.9 |
| Skewness | 6.0 |
| Kurtosis | 56.1 |

Figure 6.9 Histogram and descriptive statistics for water use per seat per day f[...] Bay Water restaurant sample (gpd).

City of Austin Lodging Sample
Annual Water Use per 100 Square Feet of Building Area per Day

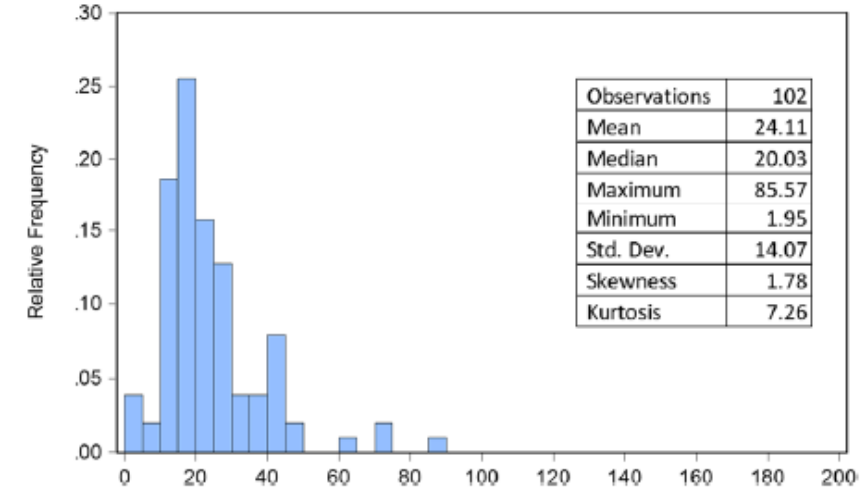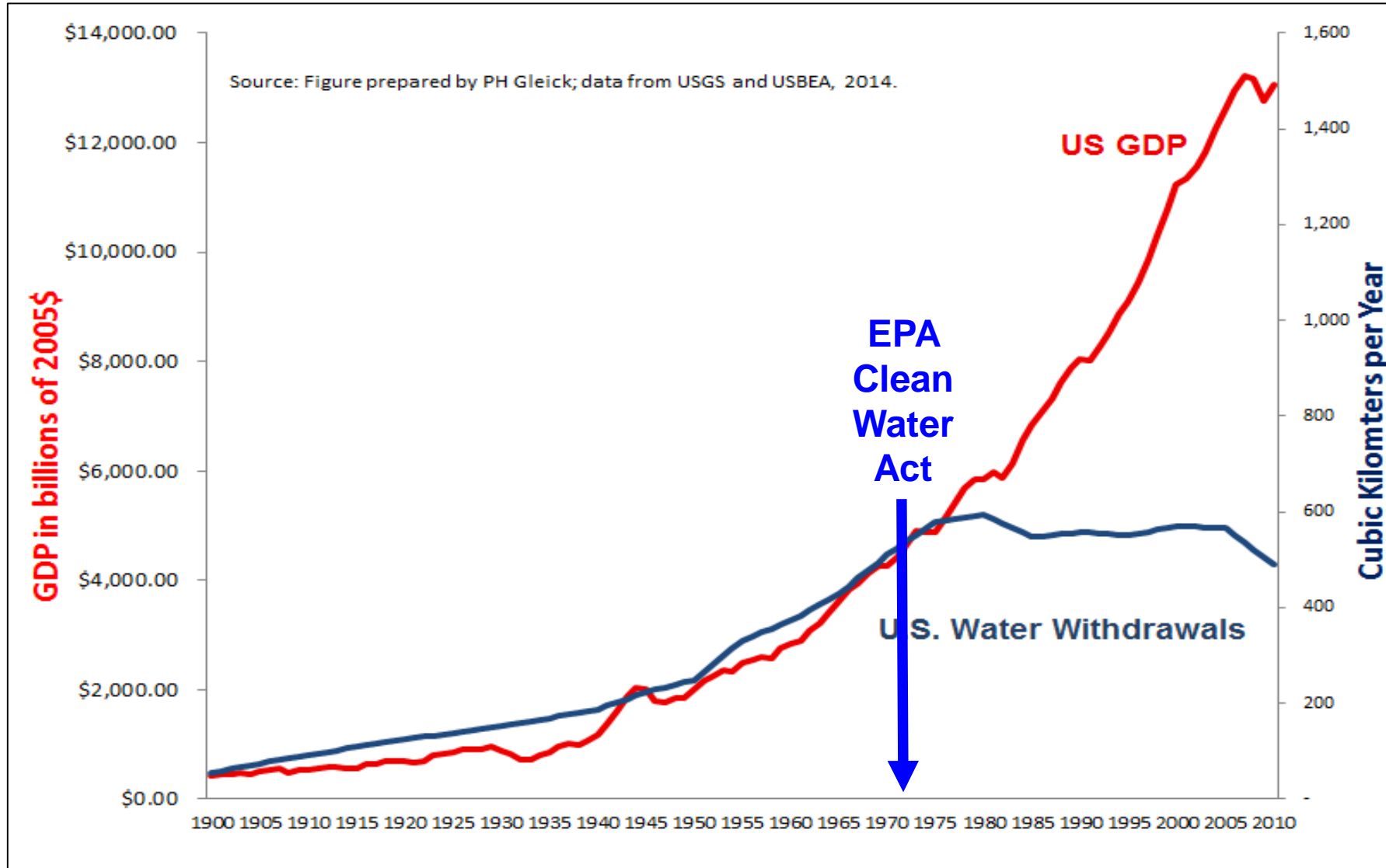| Observations | 102 |
|---|---|
| Mean | 24.11 |
| Median | 20.03 |
| Maximum | 85.57 |
| Minimum | 1.95 |
| Std. Dev. | 14.07 |
| Skewness | 1.78 |
| Kurtosis | 7.26 |

Figure 6.6 Histogram and descriptive statistics for water use per 100 square feet of building area for lodging sample from the tampa bay (FL) region (gpd)

Tampa Bay Water Lodging Sample
Annual Water Use per Lodging Room per Day

| Observations | 311 |
|---|---|
| Mean | 108.55 |
| Median | 93.87 |
| Maximum | 778.80 |
| Minimum | 0.35 |
| Std. Dev. | 83.77 |
| Skewness | 4.24 |
| Kurtosis | 29.39 |

Figure 6.7 Histogram and descriptive statistics for water use per lodging room for lodging sample from the tampa bay (FL) region (gpd)

# Industrial Benchmarking

# National Water Use vs. GDP

*Source: Peter Glick, Pacific Institute*



Source: Figure prepared by PH Gleick; data from USGS and USBEA, 2014.

US GDP

EPA Clean Water Act

U.S. Water Withdrawals
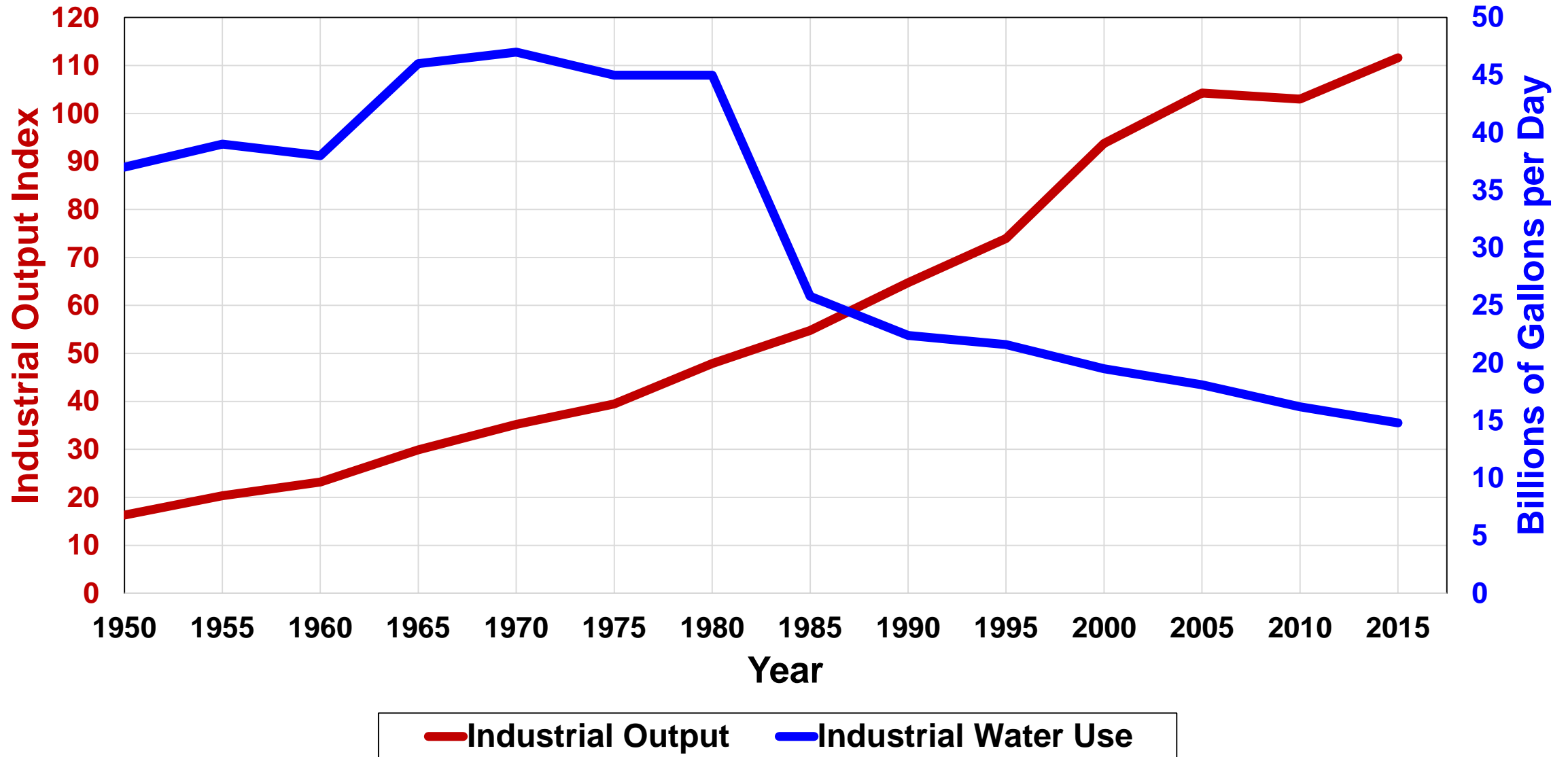
US Industrial Output Index vs Industrial Water Use

Index of Chained Dollars of Industrial Output (2009 = 100) VS Industrial Use in Billions of Gallons per Day

Sources: **USGS and US** Federal Reserve Economic Data

**Beverage Industry Continues to Drive Improvement in Water, Energy, and Emissions Efficiency**

*2018 Benchmarking Study Trends & Observations*

January 2019

### Table 1: 2018 Benchmarking Study Performance Overview

|  | 2013 | 2015 | 2017 |
|---|---|---|---|
| Total Companies Reporting | 18 | 19 | 19 |
| Total Facility Count | 1,623 | 1,696 | 1,636 |
| Total Production (Billion L) | 283 | 293 | 295 |
| Total Water Use (Billion L) | 781 | 764 | 746 |
| Total Energy Use (Billion MJ) | 217 | 215 | 202 |
| Total Emissions (MM MT CO2e) | 15.28 | 15.97 | 15.58 |
| **Water Use Ratio (WUR) (L/L)** | **2.76** | **2.61** | **2.53** |
| Brewery | 3.68 | 3.45 | 3.35 |
| Distillery | 43.28 | 34.47 | 32.68 |
| Winery * | 3.86 | 3.92 | 3.98 |
| Bottling (All) | 2.01 | 1.91 | 1.87 |
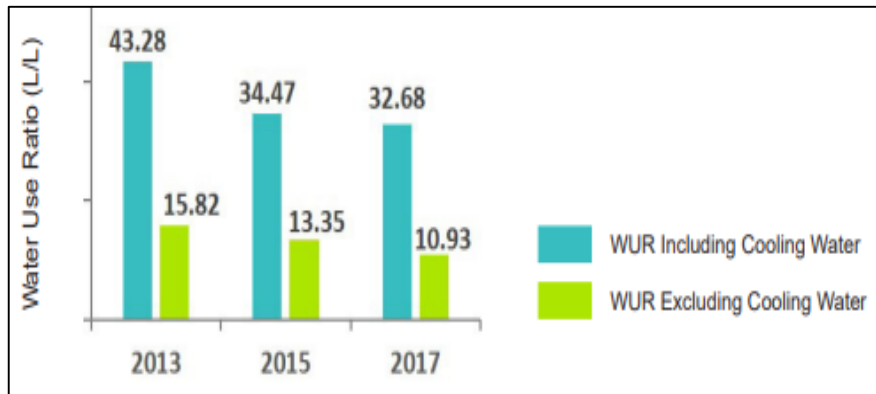


Distilleries



Wine

Gallons Use per Kilowatt Hour in Texas

Source: H.W (Bill) Hoffman & Assoc.

Gallons per Kilowatt Hour

Year

— Gallons per Total Kilowatt Hours   — Gallons per Thermal Electric Generation
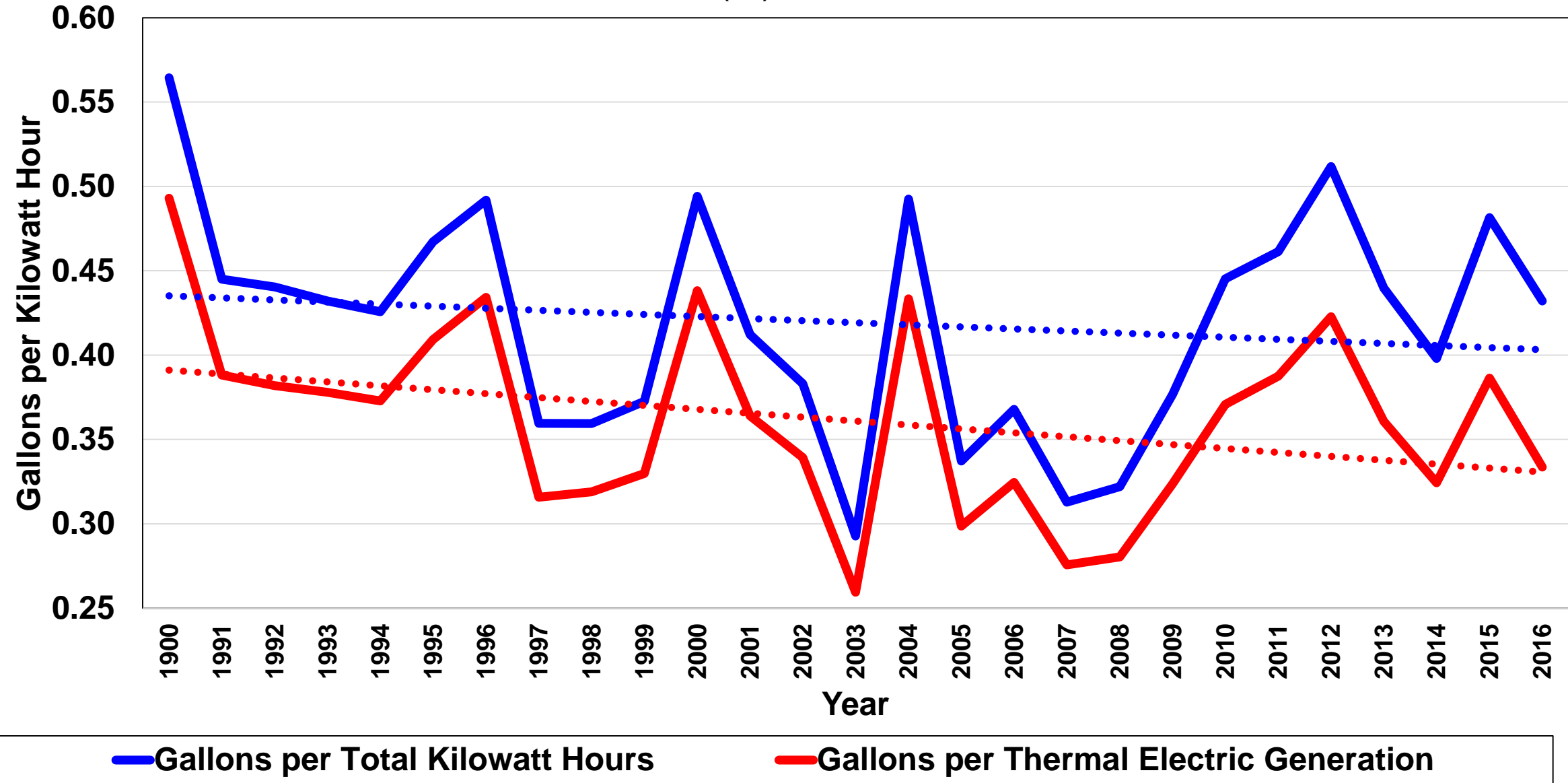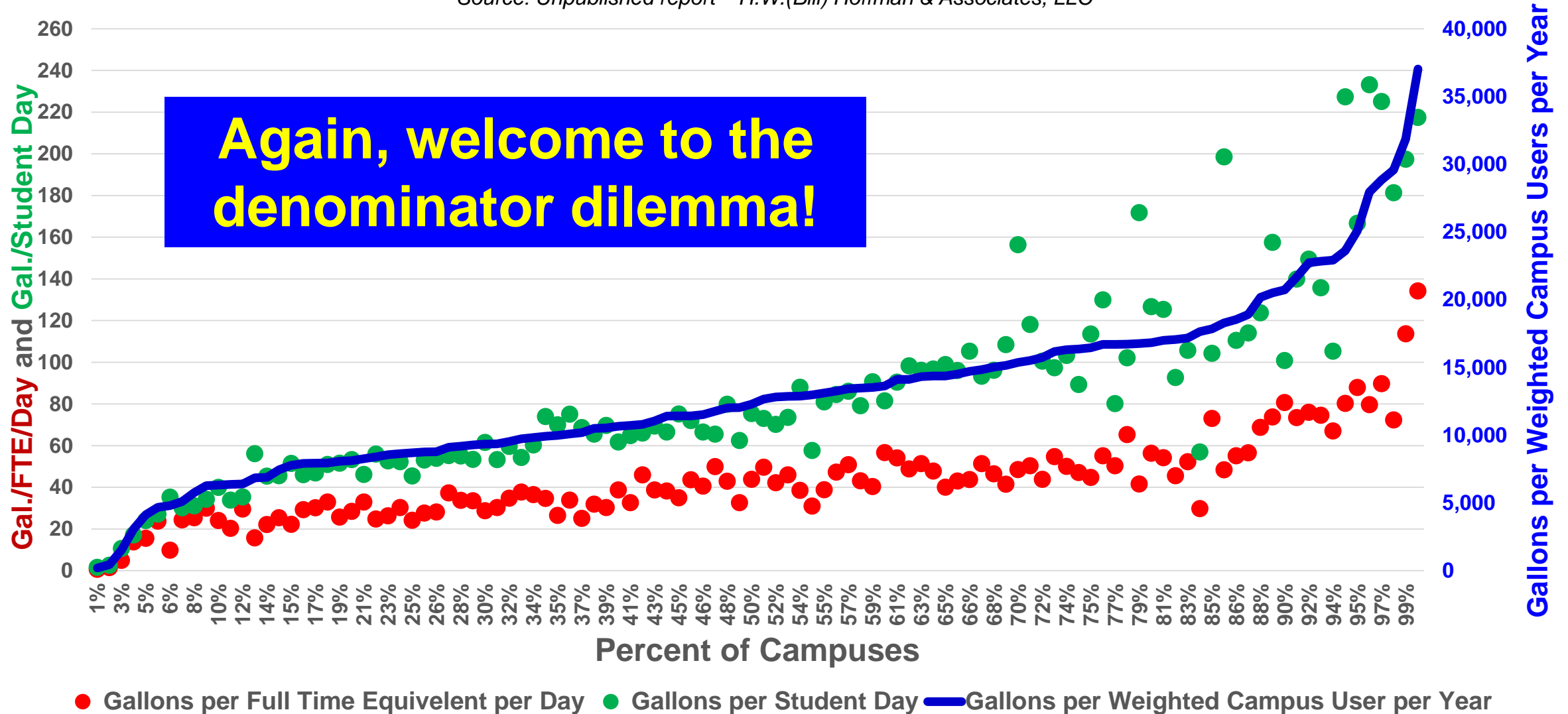
# Example Data from Older Studies

Comparison of PhD Level Universities without Hospitals
Gallons per Weighted Campus User (WCU) per Year vs Gallons per Full Time Equivalent (FTE) per Day and Gallons per Student Day
N = 110
Source: Unpublished report – H.W.(Bill) Hoffman & Associates, LLC

Again, welcome to the denominator dilemma!

• Gallons per Full Time Equivelent per Day  • Gallons per Student Day  —Gallons per Weighted Campus User per Year

# Summary of Hospital Water Use Coefficients from Various Studies

Source: H.W. (Bill) Hoffman & Associates, LLC

| Study | Gal./Bed/Day | Gal./Sq. Ft/Yr. | |
|---|---|---|---|
| | | Average | Best |
| Federal Facilities Average | | 125 | |
| Univ. of Florida Study | | 31 | |
| United Kingdom -Large Teaching | | 41 | 34 |
| UK Small Acute or Long Stay | | 29 | 22 |
| UK Small Acute or Long Stay With Laundry | | 39 | 31 |
| North Carolina Rule of Thumb | 300 | | |
| ASHE 2002 Study | 471 | | |
| Energy Star Portfolio Mgr. | 315 | | |
| Victoria Public Health Service - Australia | | 39 | 17 |
| Health Estate Journal - United Kingdom | | 87 | |
| US Energy Information Adm. 2007 study | 395 | 68 | |
| City of Austin (9 largest medical Facilities) | 335 | 58 | 18 |

## Summary of Restaurant Water Use Coefficients from Various Studies
Source: H.W. (Bill) Hoffman & Associates, LLC

| Source of Information | Best Gal./ Meal | Avg. Gal./ Meal | Gal./ sq. ft./ Year | Best Gal./ Seat/ Day | Avg. Gal./ Seat/ Day |
|---|---|---|---|---|---|
| Florida (Univ. of Fl.) Restaurant | | | 270 | | |
| Florida (Univ. of Fl.) Fast Food | | | 240 | | |
| Colorado Study (Brendle Group) | 9 to 12 | | 192 | 29 | 53 |
| USA (2000 AWWARF CI End Use Study) | | | 130 to 331 | 20 to 30 | |
| Boulder Colorado | 8 to 9 | | 125 | | 49 |
| Danamark (Canada) | | | | | |
| U of Kansas (M. Vanschenkhof) | | 12.8 | 266 | | |
| South Australia study and Sydney Water | | 9 to 12 | | | |
| North Carolina ICI BMP | | | | | 20 to 40 |
| Austin Study (Full Svc.) 2013 | | | 173 | | 31 |
| Austin Study (Fast Food) 2013 | | | 257 | | 39 |

# Benchmark Information from Sydney Australia

| Restaurants (commercial kitchens) | Benchmark |
|---|---|
| | Gallons per Food Cover |
| Efficient | <9.2 |
| Fair | 9.2 - 11.1 |
| Inefficient | >11.9 |

| Clubs | Benchmark |
|---|---|
| | Gallons per Customer |
| No Cooling Tower or Pool | 5.3 |
| Cooling Tower but no Pool | 5.8 |
| Cooling tower and a Pool | 7.4 |

| Commercial Laundries | Benchmark | |
|---|---|---|
| | Gallons per Pound of Laundry | |
| | Without Reuse | With Reuse |
| Efficient | 2.0 to 2.6 | 1.4 to 1.8 |
| Fair | 2.2 to 63.1 | 1.8 to 2.2 |
| Inefficient | > 3.1 | > 2.2 |

| Office Building/Shopping Center | Benchmark | |
|---|---|---|
| | Gallons per Square Foot per Year | |
| | With a Cooling Tower | Without a Cooling Tower |
| Best | 19 | 10 |
| Efficient | 21 | 12 |
| Fair | 25 | 16 |

# So How Can I Use This Information in My Program

# Which Facilities Do I Visit First

# Tampa Restaurant Example

Tampa Bay Water Restaurant Sample
Annual Water Use per Seat per Day

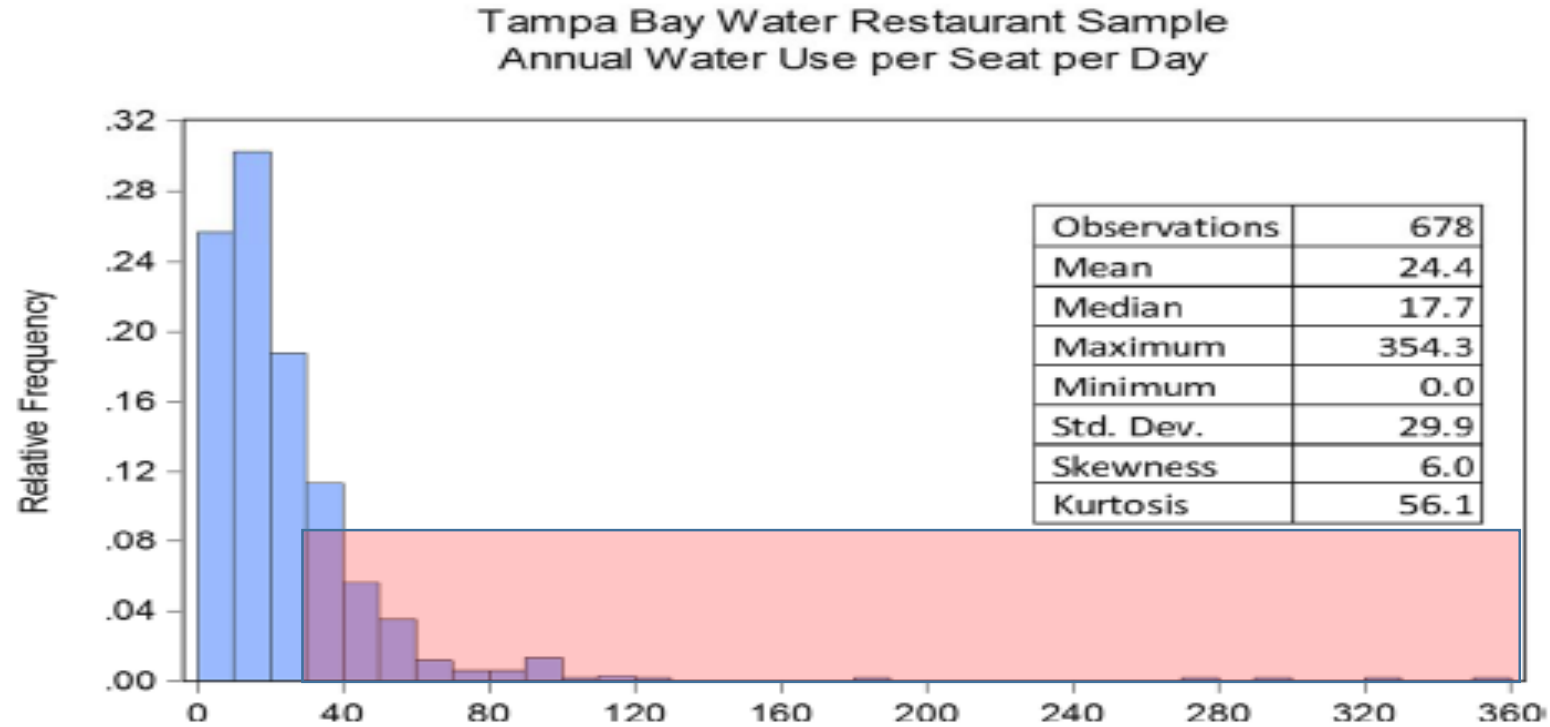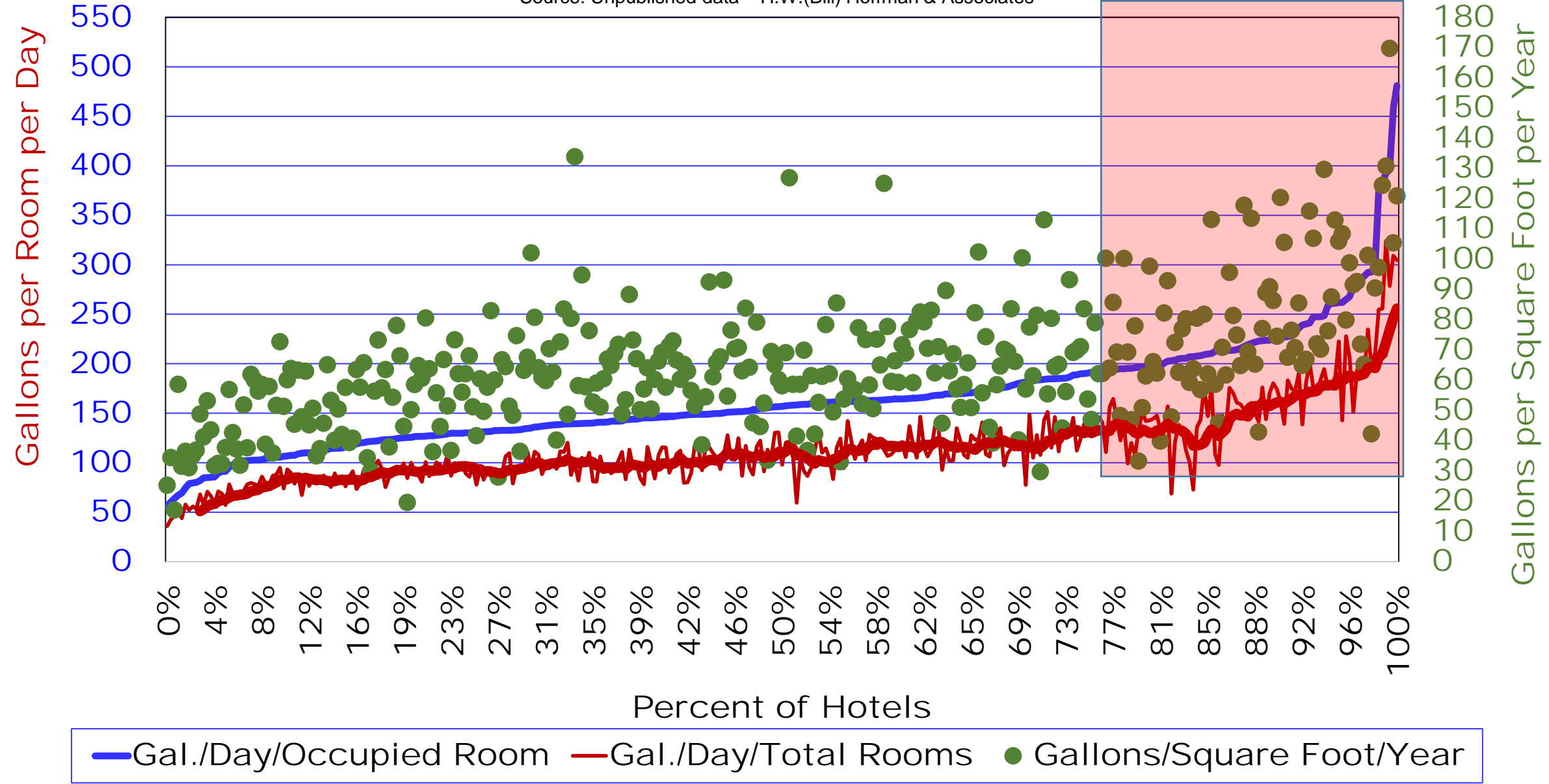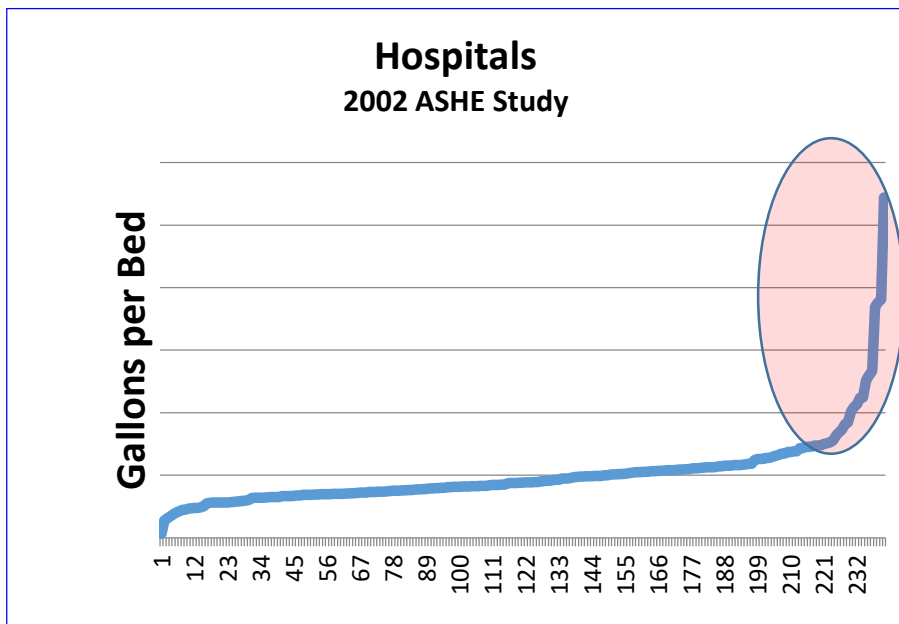| Observations | 678 |
|---|---|
| Mean | 24.4 |
| Median | 17.7 |
| Maximum | 354.3 |
| Minimum | 0.0 |
| Std. Dev. | 29.9 |
| Skewness | 6.0 |
| Kurtosis | 56.1 |

**Figure 6.9 Histogram and descriptive statistics for water use per seat per day for Tampa Bay Water restaurant sample (gpd).**

| | | Table 6.9 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Water use per seat by restaurant sub-class for Tampa Bay Water sample | | | | | | |
| Restaurant Class | Obs. | Mean | Median | Max | Min | Std. Deviation | Skewness | Kurtosis |
| Fast Food | 257 | 31.1 | 24.7 | 273.0 | 0.0 | 27.7 | 3.4 | 25.4 |
| Full Service | 421 | 20.3 | 14.7 | 354.3 | 0.0 | 30.4 | 7.7 | 75.8 |
| All | 678 | 24.4 | 17.7 | 354.3 | 0.0 | 29.9 | 6.0 | 56.1 |

Data from 339 Hotels

Source: Unpublished data – H.W.(Bill) Hoffman & Associates
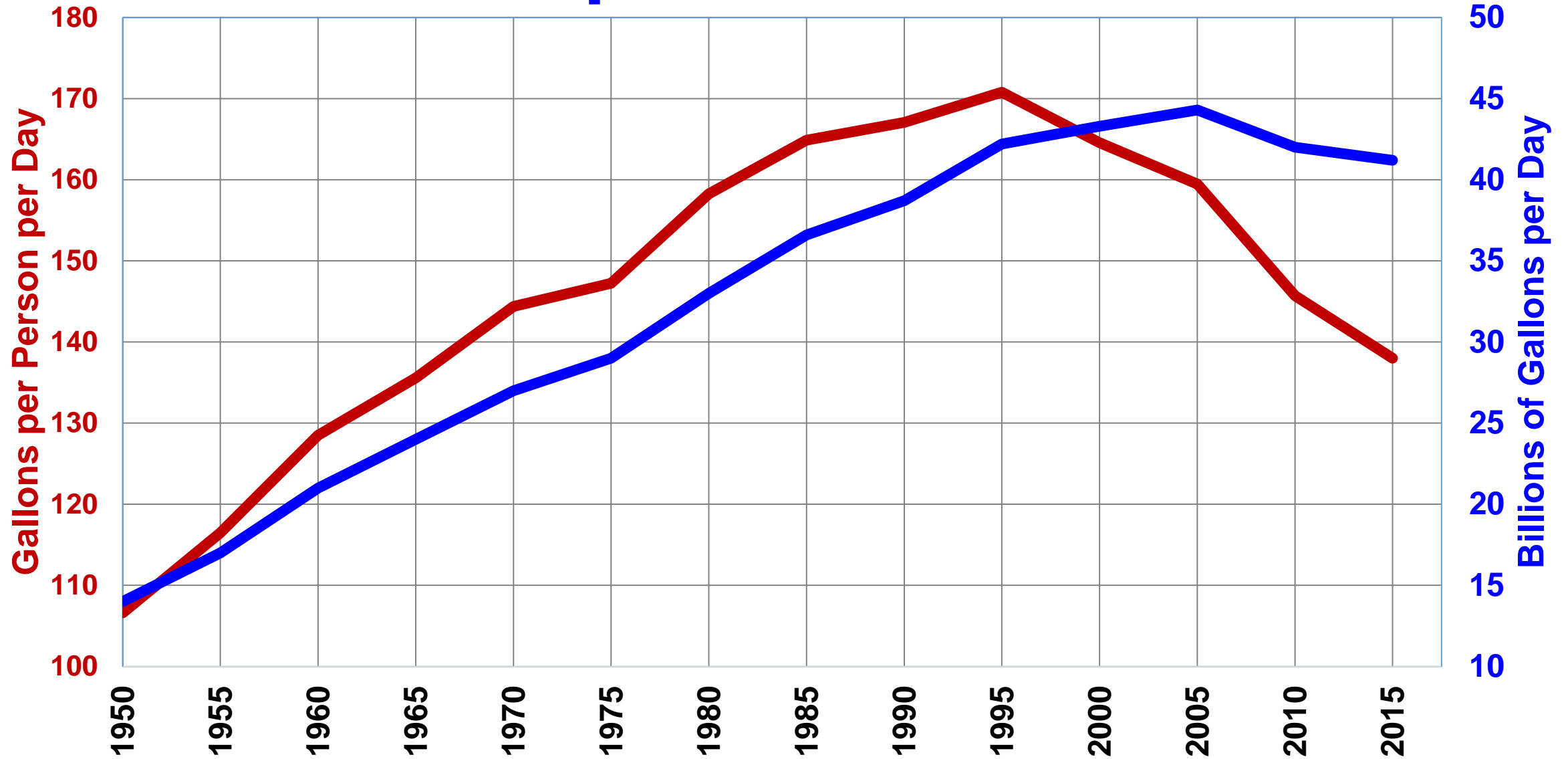
Percent of Hotels

— Gal./Day/Occupied Room  — Gal./Day/Total Rooms  ● Gallons/Square Foot/Year

**Hospitals**
2002 ASHE Study

Gallons per Bed

1 12 23 34 45 56 67 78 89 100 111 122 133 144 155 166 177 188 199 210 221 232

**Do You see the same Pattern Here?**

**Elementary Schools in Texas**

GPCD

70
60
50
40
30
20
10
0

1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76

**Histogram of DOR 41 - Light Industrial**
(gallons per square foot of heated area)

Gallons per Square Foot of Heated Area

150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

| Median | 4.9 |
| Mean | 10.7 |
| 25 percentile | 2.1 |
| 75 percentile | 13.0 |
| Range | 0.01 to 142 |
| No. of Observations | 147 |

1% 4% 7% 11% 14% 18% 21% 24% 28% 31% 35% 38% 41% 45% 48% 52% 55% 59% 62% 65% 69% 72% 76% 79% 82% 86% 89% 93% 96% 99%
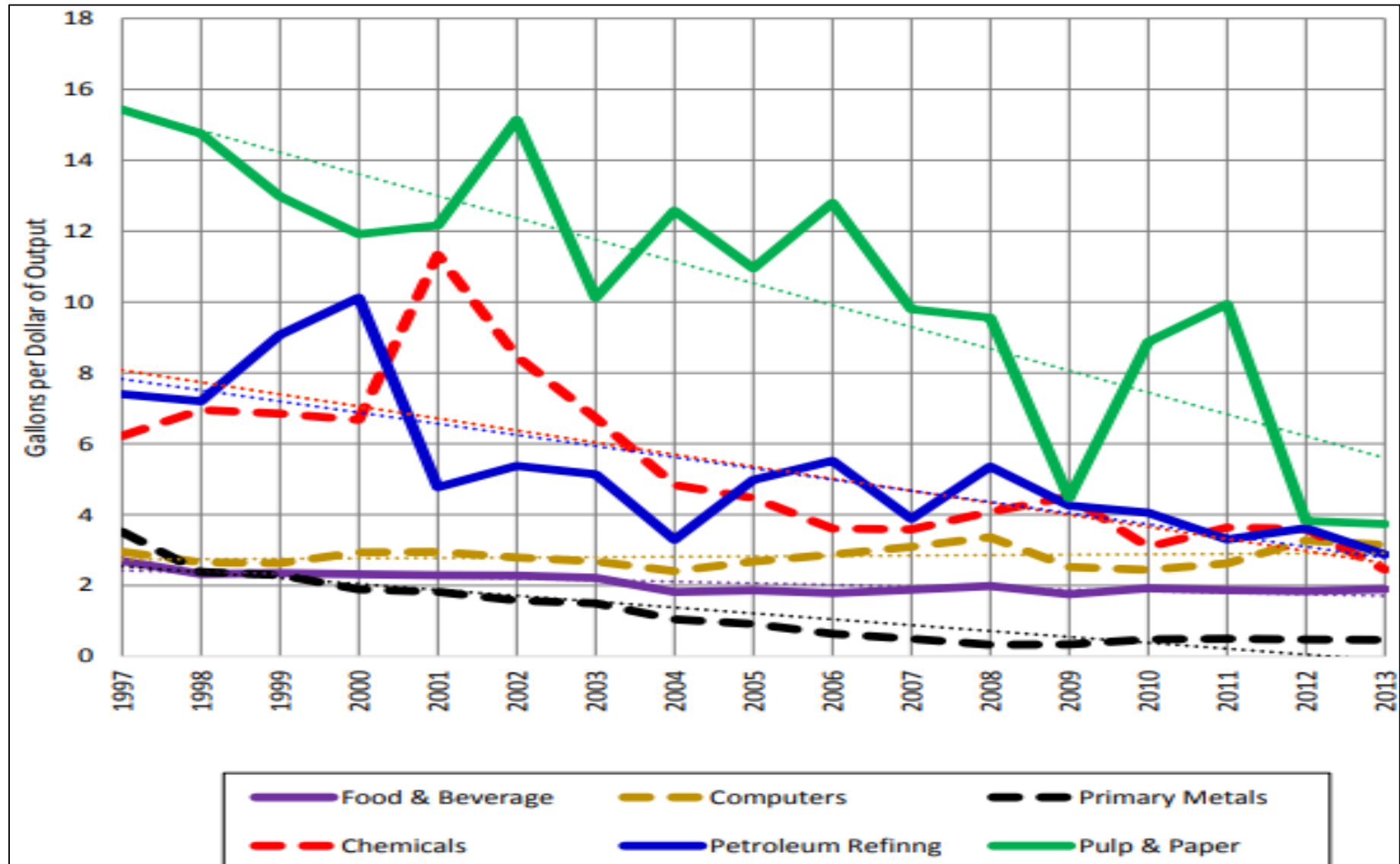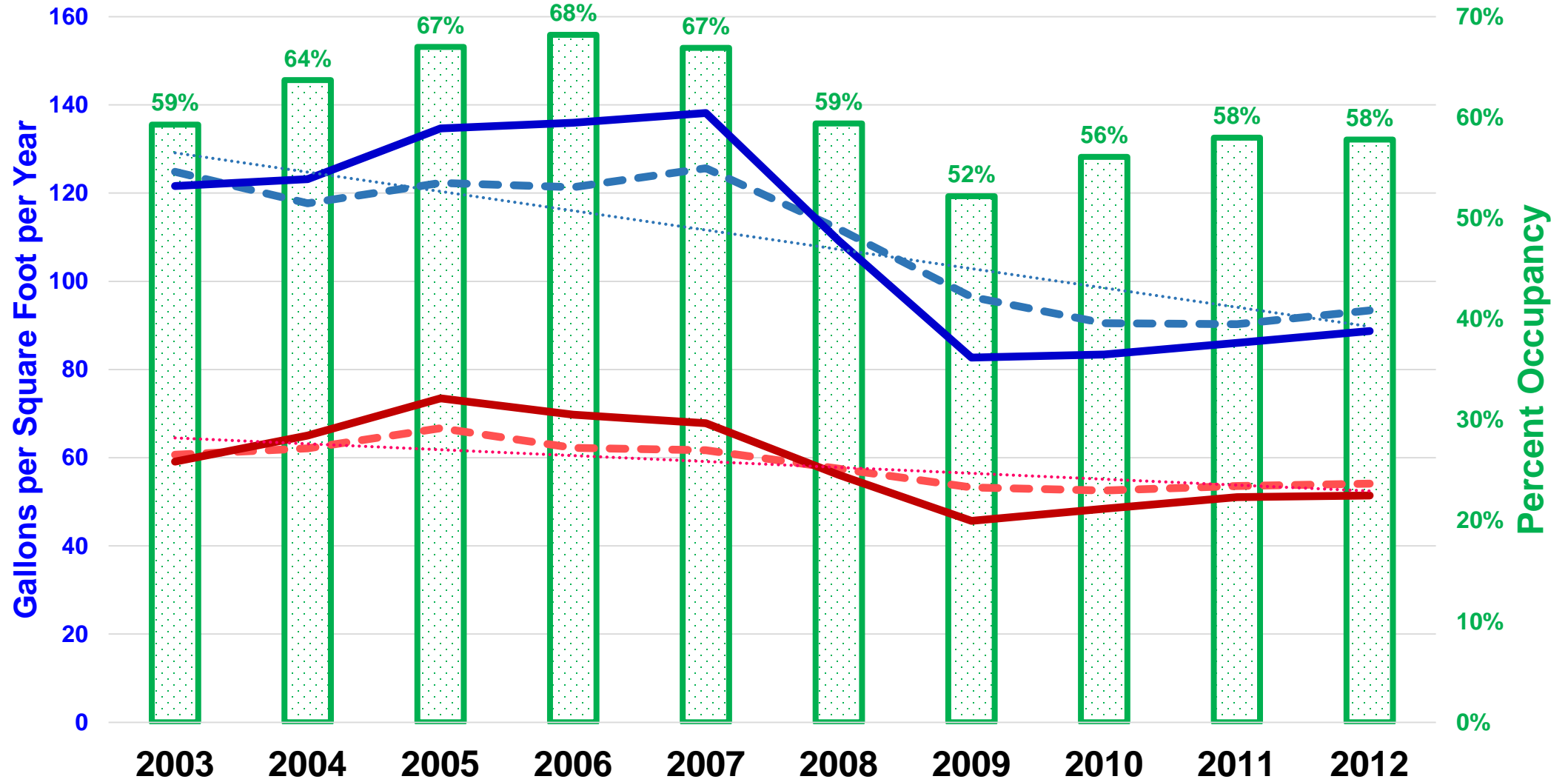
# So is it working

Municipal Water Use in USA

# Water Use per Dollar of _Inflation Adjusted_ Output in Texas

# Hotel and Motel Water Use Factors for Phoenix - 2003 to 2012



Legend:
- Percent Occupancy
- Motel Adjusted for Occupancy
- Motel Unadjusted for Occupancy
- Hotel Adjusted for Occupancy
- Hotel Unadjusted for Occupancy

Y-axis (left): Gallons per Square Foot per Year (0 to 160)
Y-axis (right): Percent Occupancy (0% to 70%)
X-axis: 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012

Percent Occupancy values: 59%, 64%, 67%, 68%, 67%, 59%, 52%, 56%, 58%, 58%

# Time Series

# Total Restaurant Water Use in Austin Texas
## from August 2010 through August 2011

Millions of Gallons per Day

| Month | Value |
|-------|-------|
| Aug. 2010 | 1.6 |
| Sept. 2010 | 1.7 |
| Oct. 2010 | 1.6 |
| Nov. 2010 | 1.8 |
| Dec. 2010 | 1.7 |
| Jan. 2011 | 1.6 |
| Feb. 2011 | 1.8 |
| Mar. 2011 | 1.8 |
| Apr. 2011 | 1.8 |
| May. 2011 | 1.9 |
| June. 2011 | 1.9 |
| July. 2011 | 1.8 |
| Aug. 2011 | 1.9 |
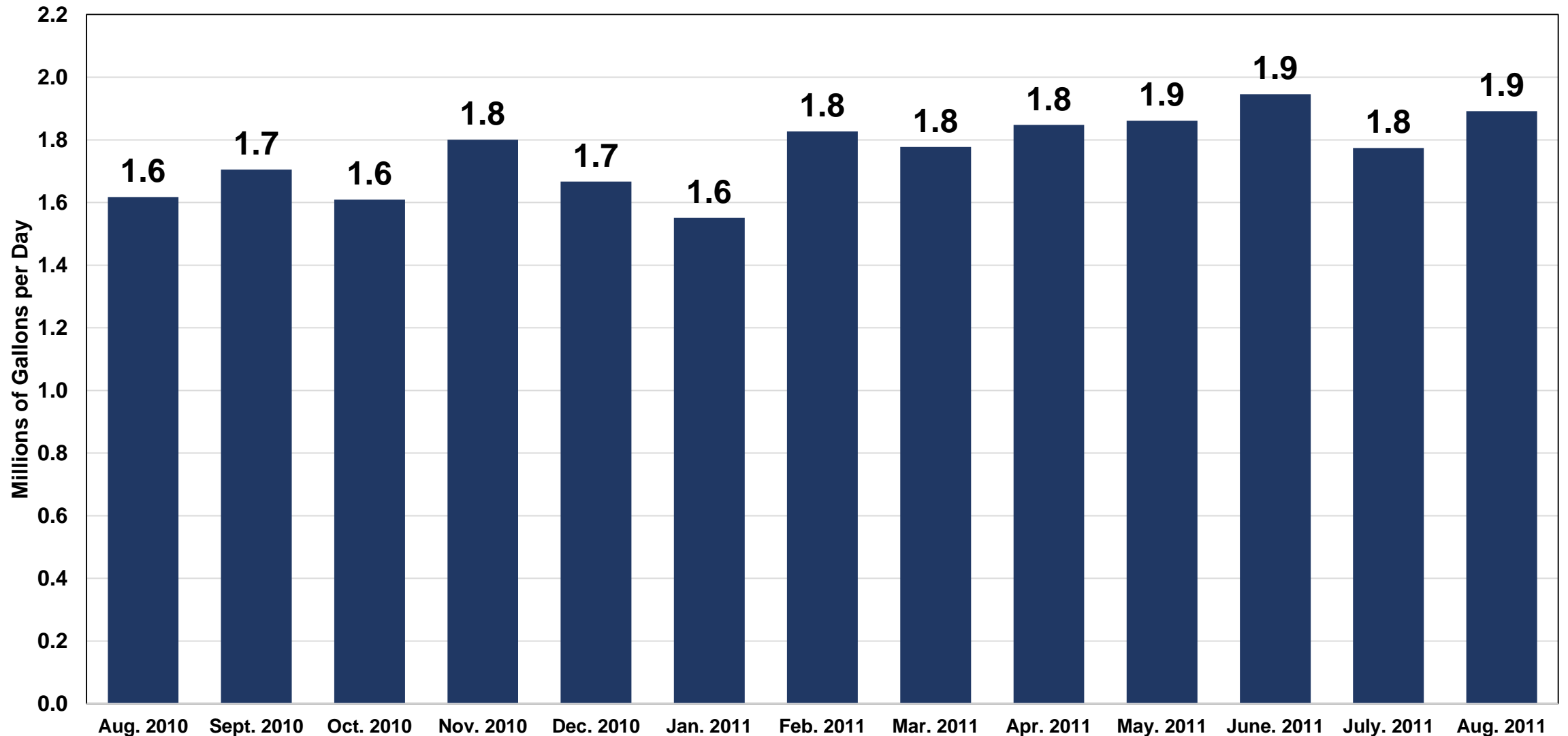
Monthly Percent of Annual Use for 15 Hotels In New Mexico, Arizona, and West Texas 2011-2012
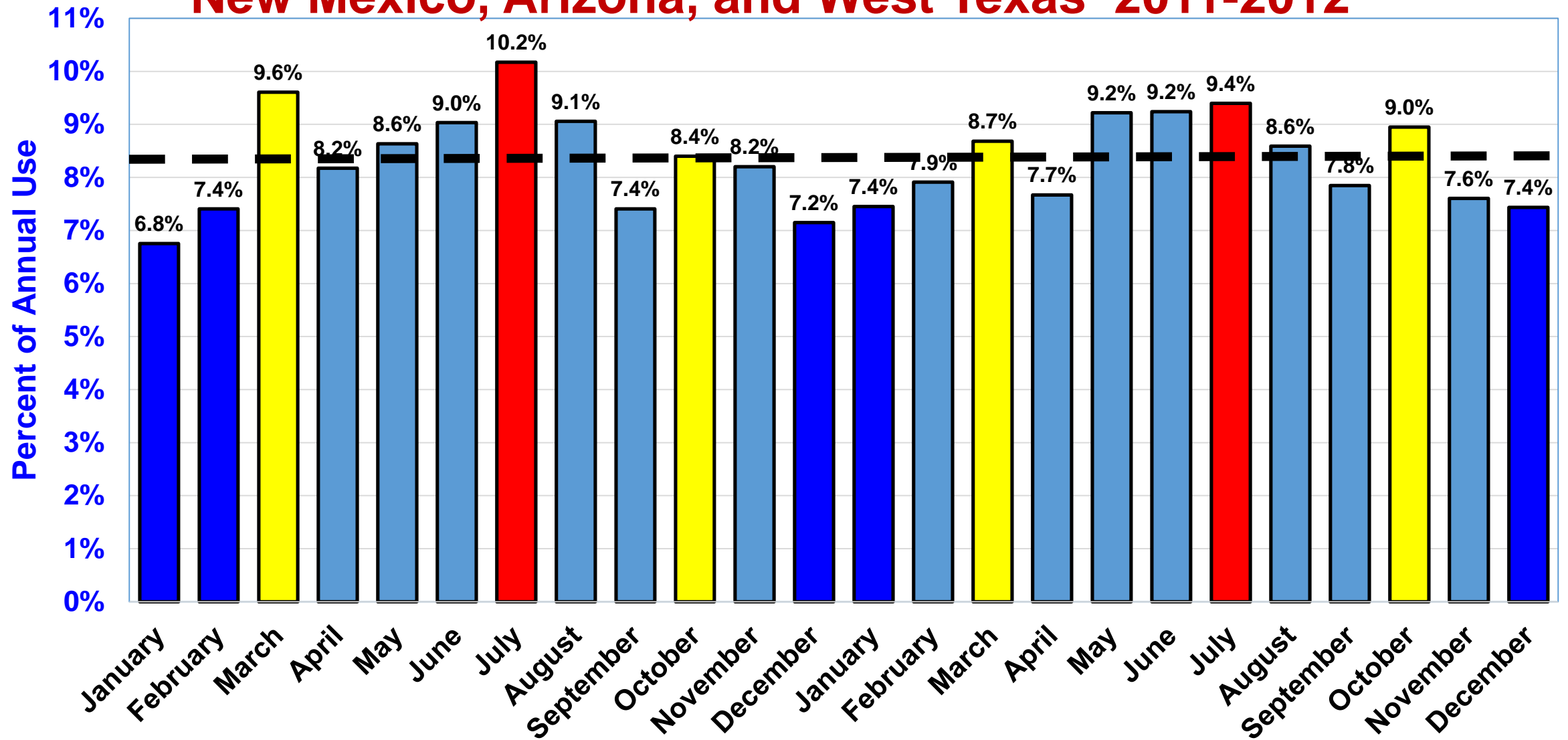
**Estimated Change in**
**_Indoor Residential_**
**Per Capita Use in USA _a 55% Decrease_**
*Sources: AWWARF Studies*

Gallons per Person per Day

| Year | Value |
|------|-------|
| 1990 | 75 |
| 1995 | 73 |
| 2000 | 69 |
| 2005 | 60 |
| 2010 | 55 |
| 2015 | 53 |
| Future | 34 |
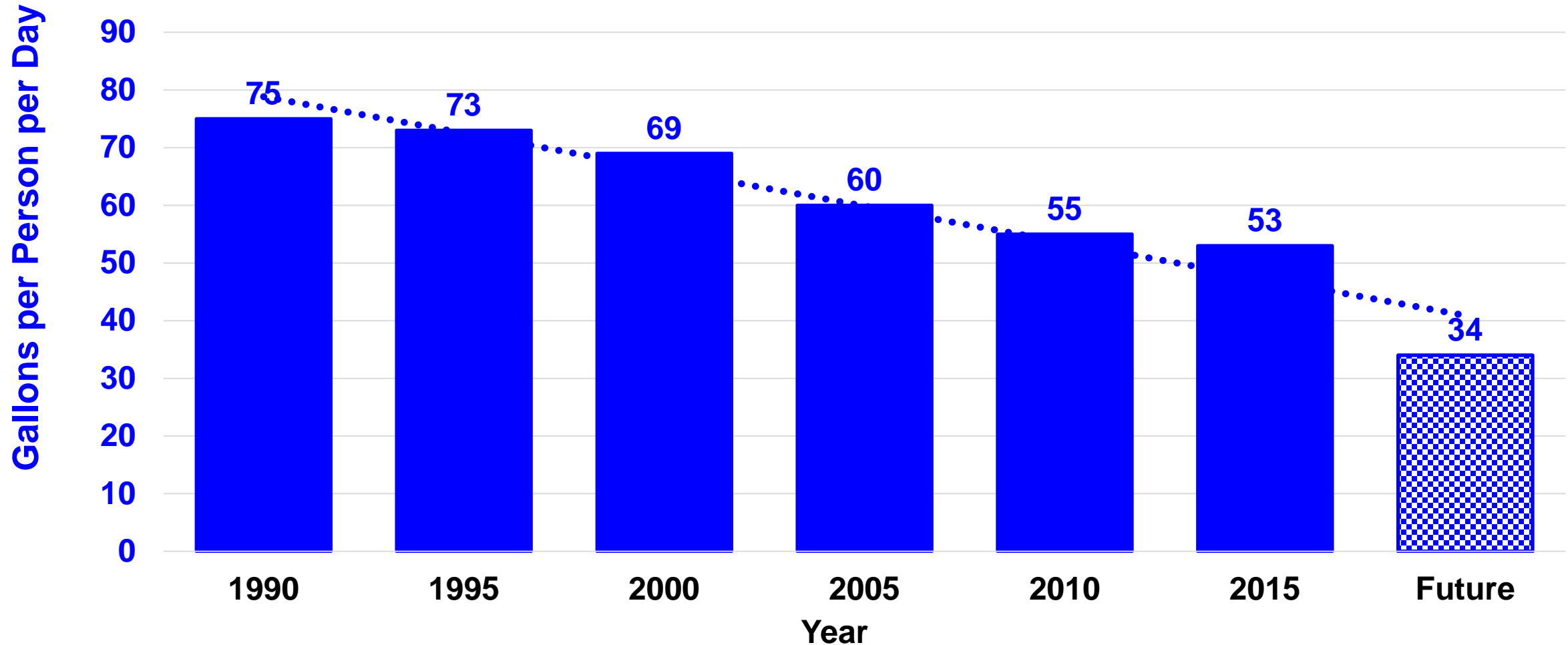
# Big Data is Coming
## Soon to your city!

# The Coming *Deluge* of Data

*How to make it work for us.*

- **Major new benchmarking efforts nation wide**
- **Energy Star Portfolio Manager**
- **Better Buildings Challenge**
- **2030 District Network**

- **AMI**
- **The IOT**
- **GIS**
- **Drones and Satellites**
- **????????????????**

# In the Next 20 Years, All Water Utilities Will Be Using AMI

## Advanced Metering Infrastructure



GALAXY Transmitter with Model 25 Meter

By adding *facility type*, and basic *operational parameters.*

We are getting the tools!

# Examples of Possible Denominators

| Facility Type | Function Metric | Facility Metric | Other People Metrics |
|---|---|---|---|
| Hotel | Guests | Rooms, Square Feet | Employees |
| Hospital | Patients, Discharges, Out-Patients, Patient Nights | Beds, Occupied Beds, Square Feet | Employees |
| Clinics | Patients, Procedures | Chairs (dental) Square Feet | Employees |
| School | Students | Square Feet | Faculty, Staff |
| Restaurant | Meals Served, Covers, Tickets | Number of Seats, Square Feet | Employees |
| Office | Employees, Visitors | Square Feet | |
| Retirement Home | Residents | Rooms, Beds, Square Feet | Employees |
| Commercial Laundries | Pounds of Laundry | Washer Capacity, Square Feet | Employees |
| Multi-Family | Number of Residents | Dwelling Units, Square Feet | Bedrooms |
| Automotive Shop | Vehicles Serviced | Square Feet, Number of Bays | Employees |
| Manufacturing | Units of Product Produced, Dollars Produced | Square Feet, Number of Pieces of Equipment | Employees |
| Retail | Customers, Number of Transactions | Square Feet | Employees |
| Grocery | Customers, Number of Transactions | Square Feet | Employees |

# Conclusion and Observations

- **Benchmarking lets you know where you have been.**

- **Benchmarking allows you to compare water use by type of facility.**

- **Knowing what the benchmarks by user type for your community can help identify opportunities and follow your program's progress.**

- **Climate, practice and your local characteristics make your utility benchmarks unique.**

# The Coming Data Deluge

- AMI means we will have water use **_data_** flowing out of our ears

- Adding denominators to the data will produce **_information_**

- Understanding this information leads to **_understanding_**

- From understanding, **_knowledge_**
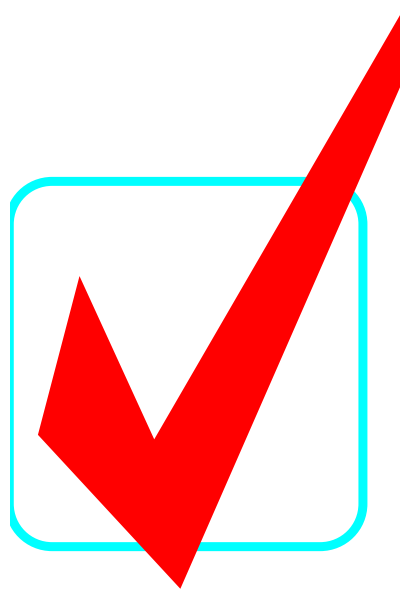
- From knowledge, comes **_wisdom_**

# If you *don't* measure it, you CAN NOT manage it!

# Questions?

The

✓

End

# The Status of Benchmarking ICI Water Use

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*WaterSmart Innovations 2019*