

Energy meets Water

Synergies and Conflicts

by

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Factoids

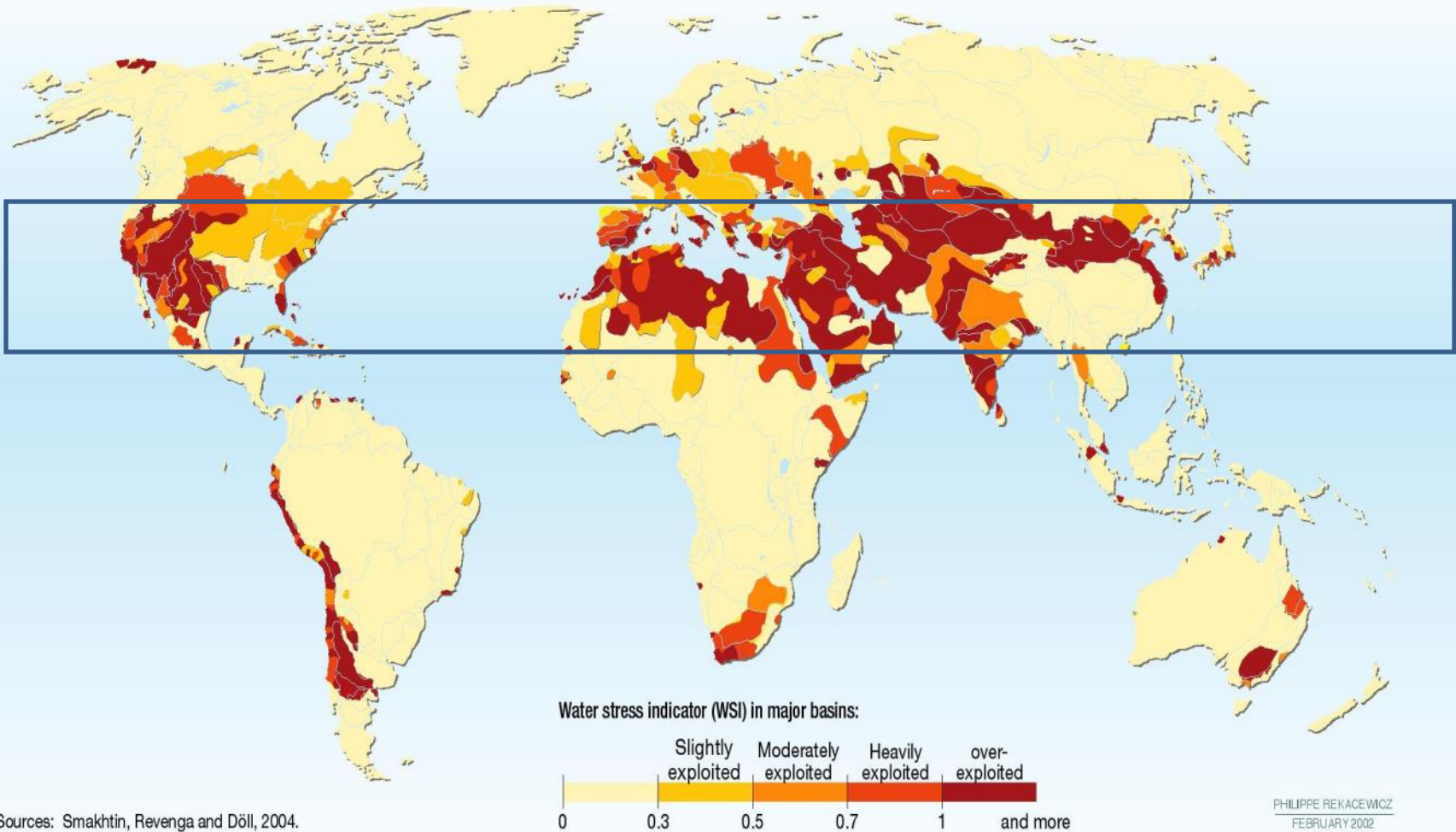
- **24 Bills currently before congress address water efficiency**
- **Since 2001, water and wastewater costs have increased 1.45 times faster than electricity costs.**
- **In office buildings, cooling towers are the major consumptive use.**
- **~Brewers worry that national water shortages will raise prices of BEER!~**

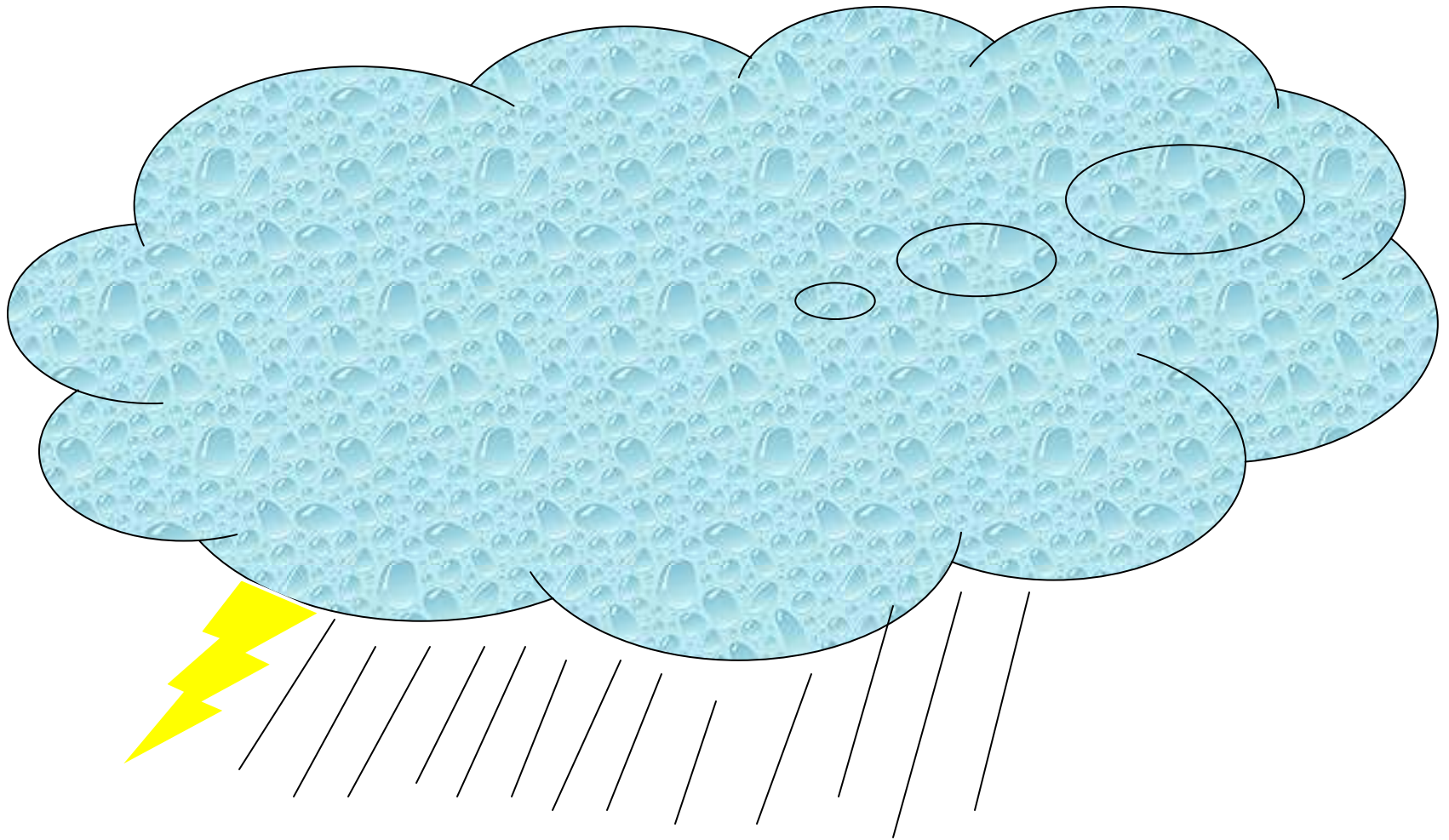
**“Water is the oil of
the 21st century.”**

*Andrew Liveris,
Chief Executive,
Dow Chemical Co.,
August 2008.*

Water Stress Indicators

The latitude of stress

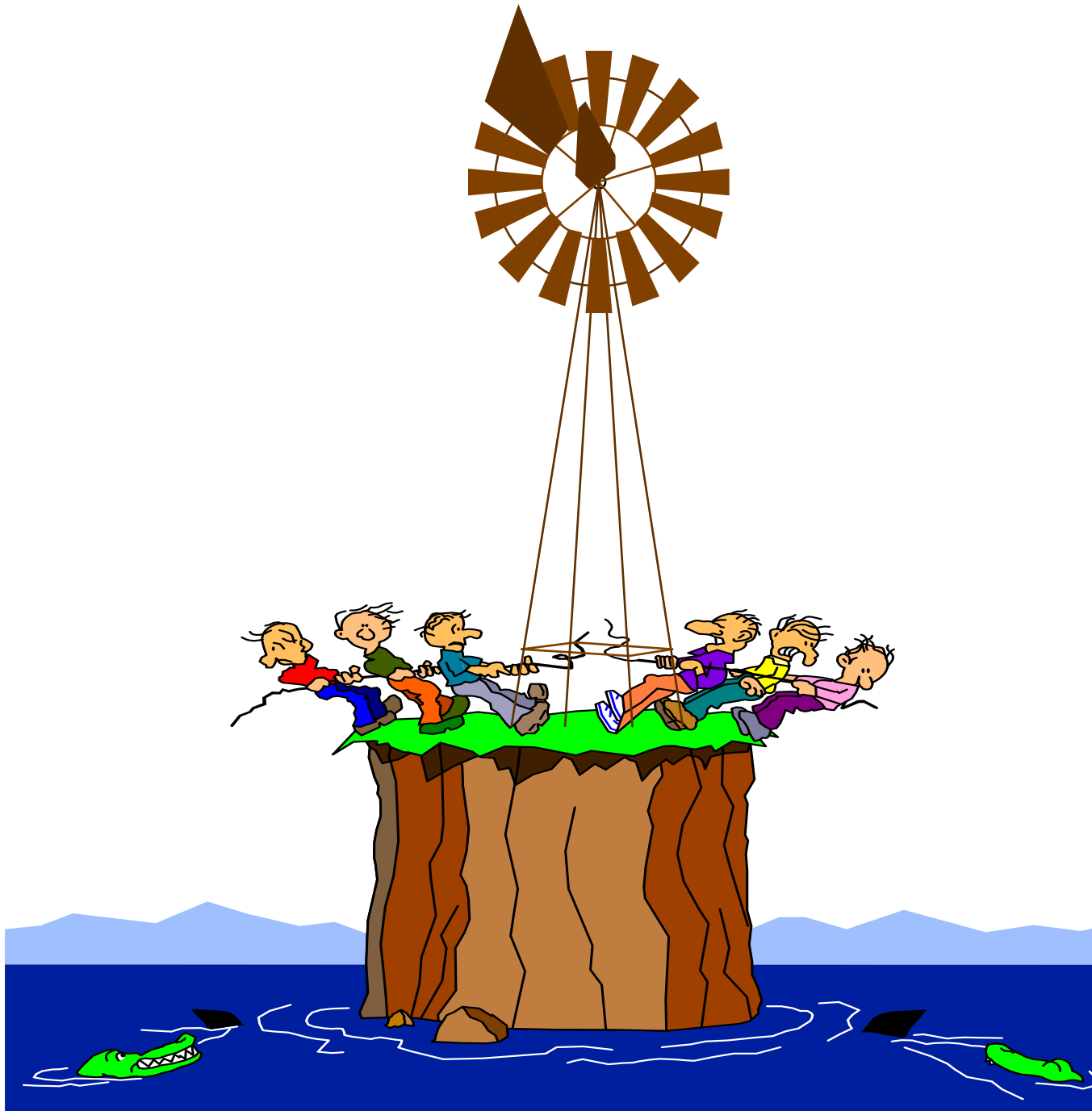




The ultimate source of all of our *fresh* water is precipitation

***Fresh water is an
infinitely
replenishable
resource***

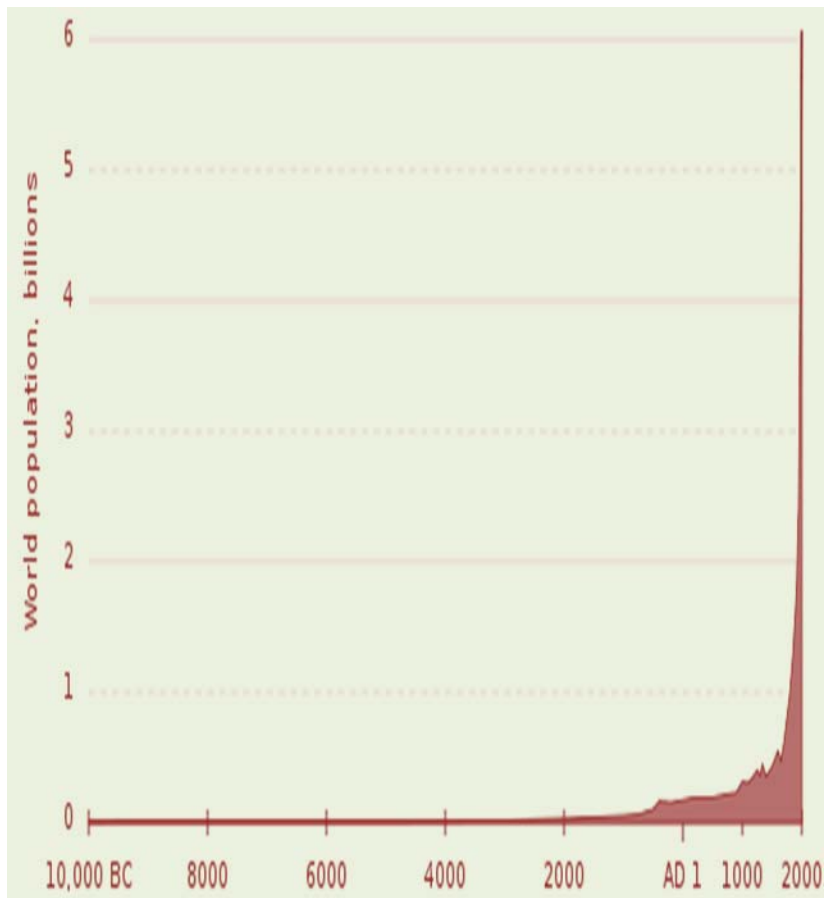
***but at a finite and
variable rate.***



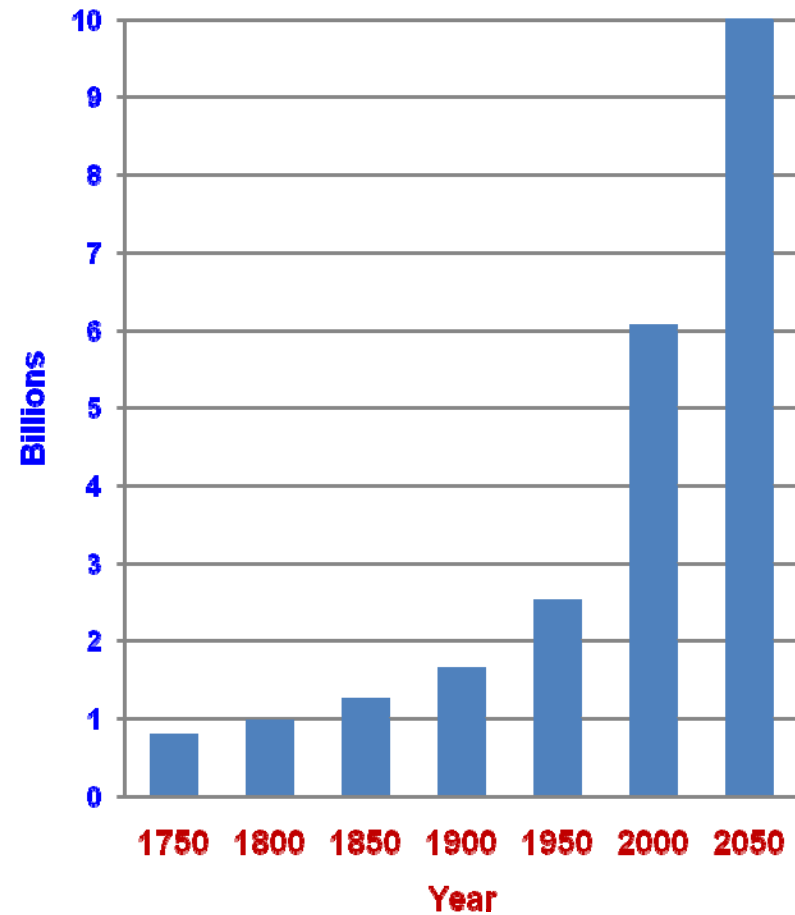
You can
only get as
much as
mother
nature
allows you
to. Any
more &
????

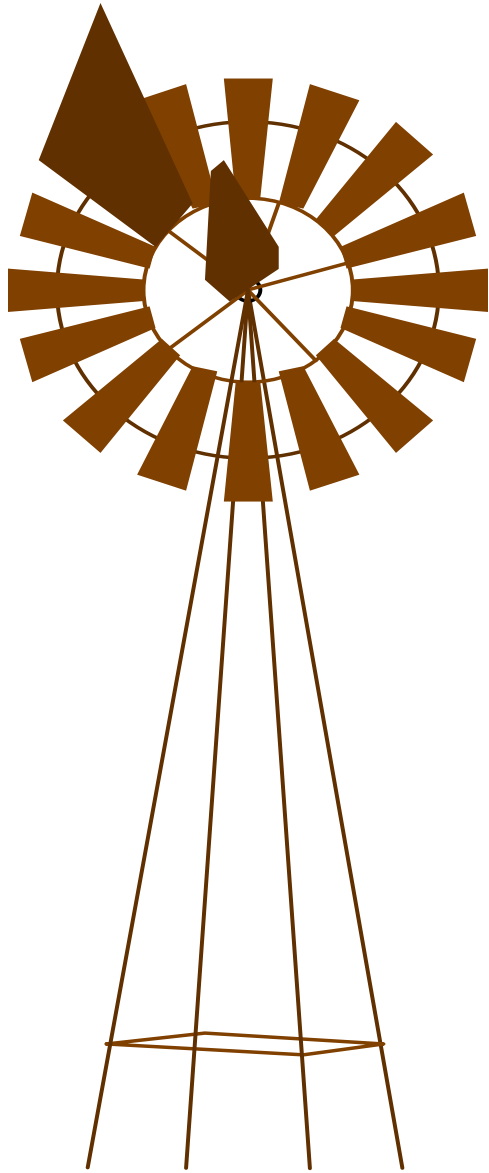
World Population

Population over Human History



World Population since 1750





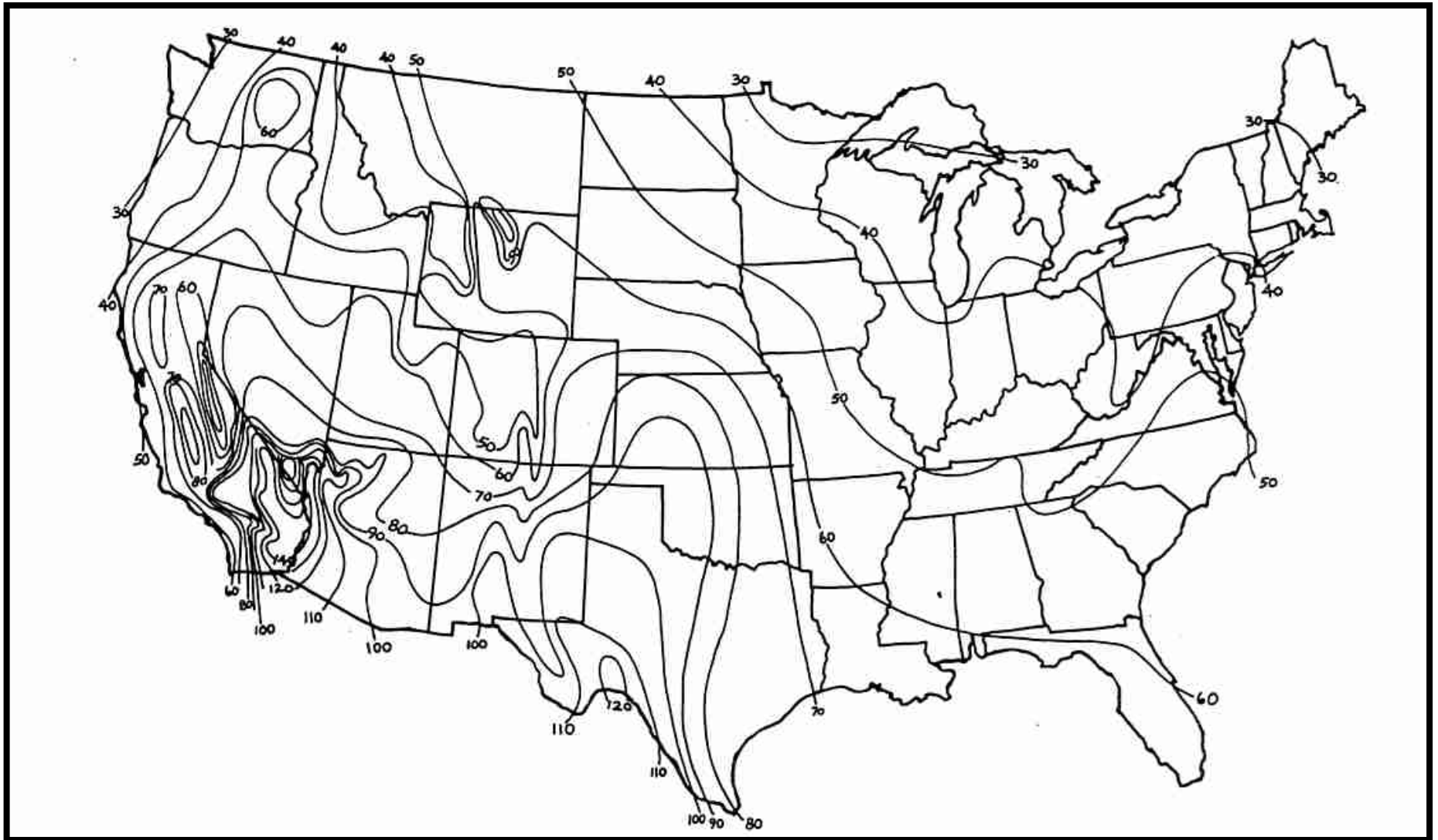
Texas Groundwater Example

State-wide -

- *4 to 5 Billion Gal./Day recharge*
- *6 to 8 Billion Gal./Day withdrawal*

You don't have to be a rocket scientist to figure this one out!

Annual evaporation map from the National Weather Service



Lake Mead *(Hoover Dam)*

**Loses one billion
gallons of water a
day to evaporation!**

The Big Day of Dam Building is Over

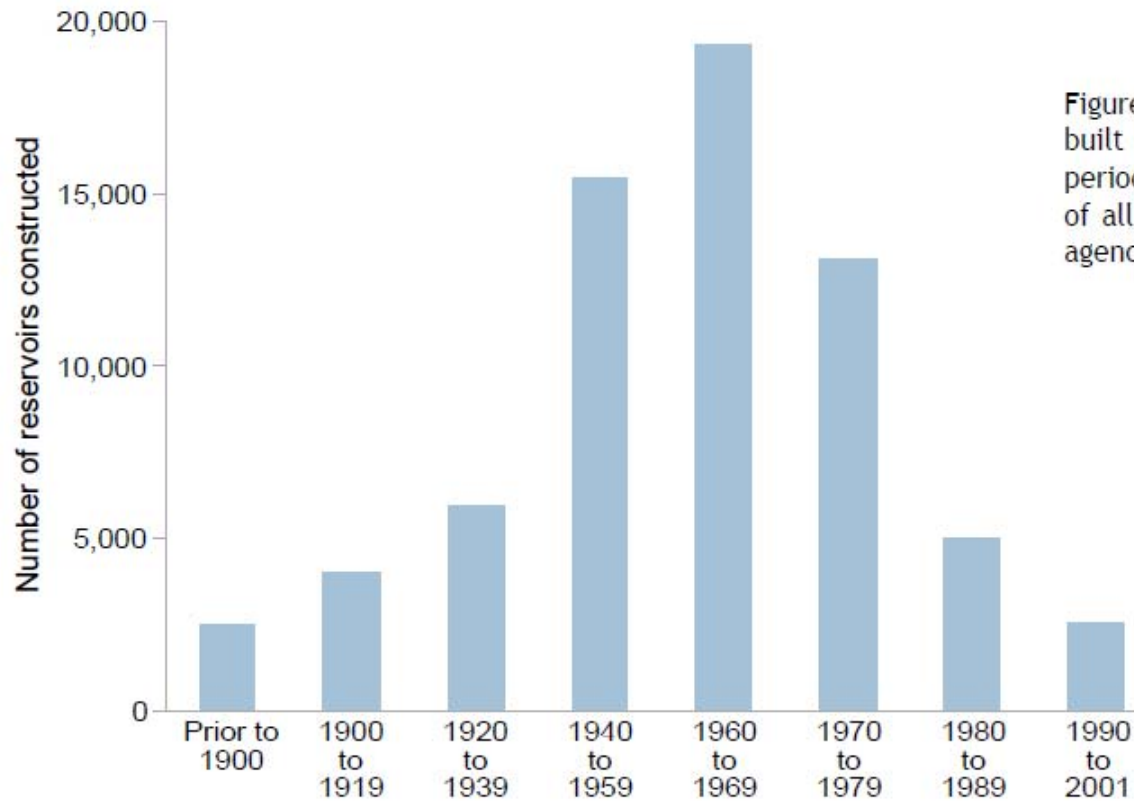
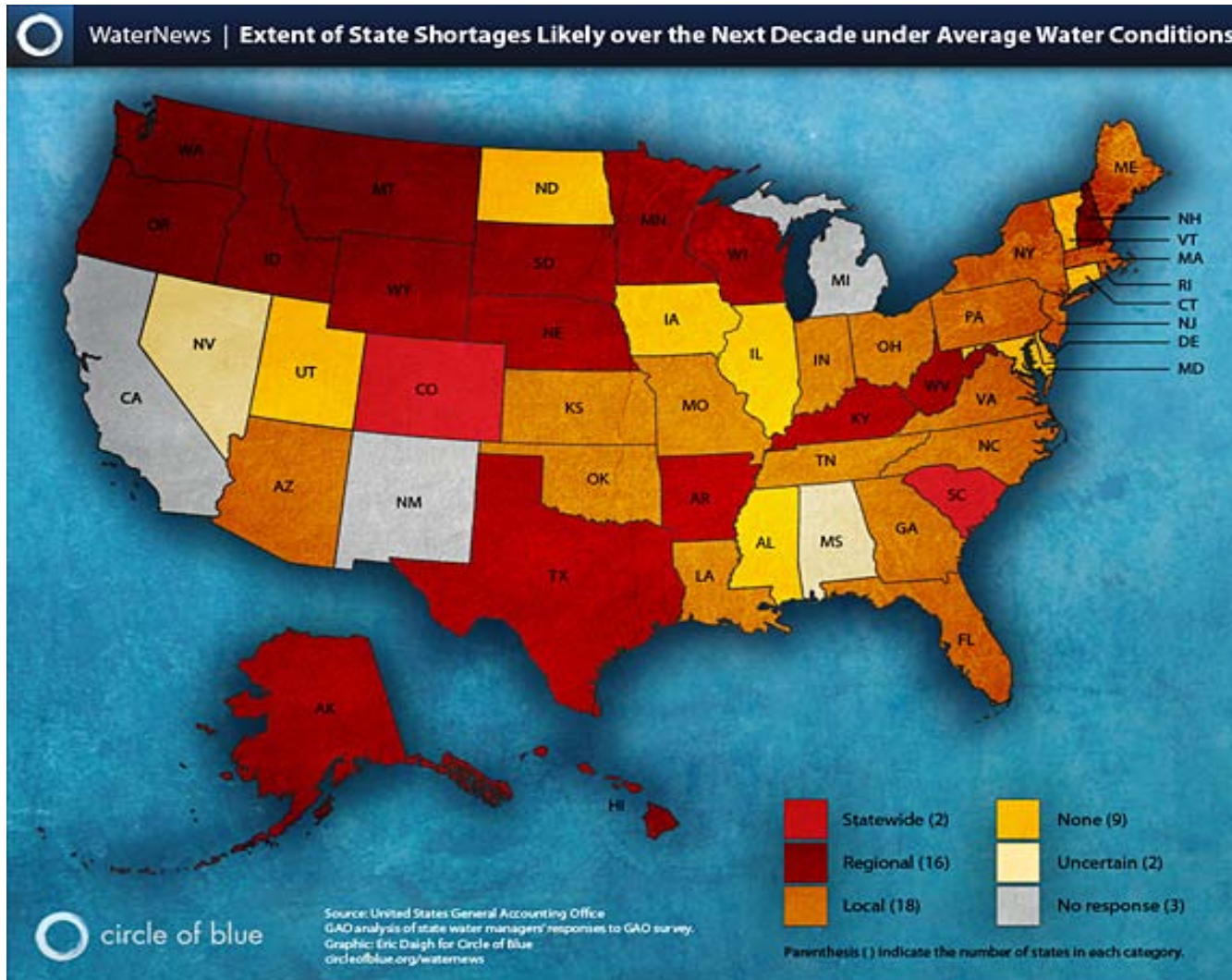


Figure 3.1. The number of reservoirs built in the United States by time period. This figure includes dams of all sizes recorded by regulatory agencies (Gleick, 2000).

Other limitations to New Dams

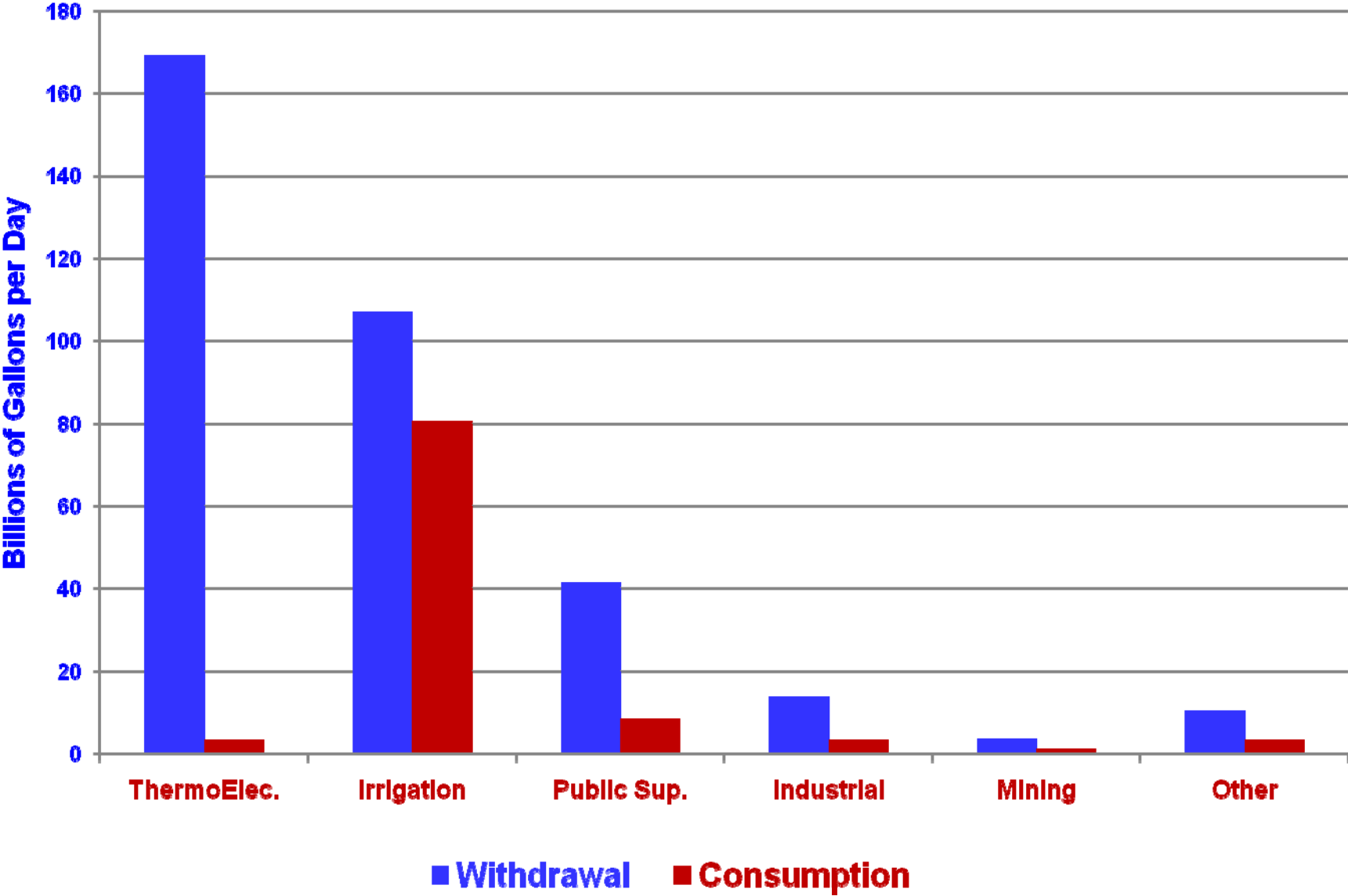
- **Environmental costs and limitations**
- **Availability of new conventional sources limited**
- **Political implications**

GAO – Water Shortage in 36 States by 2013 Possible

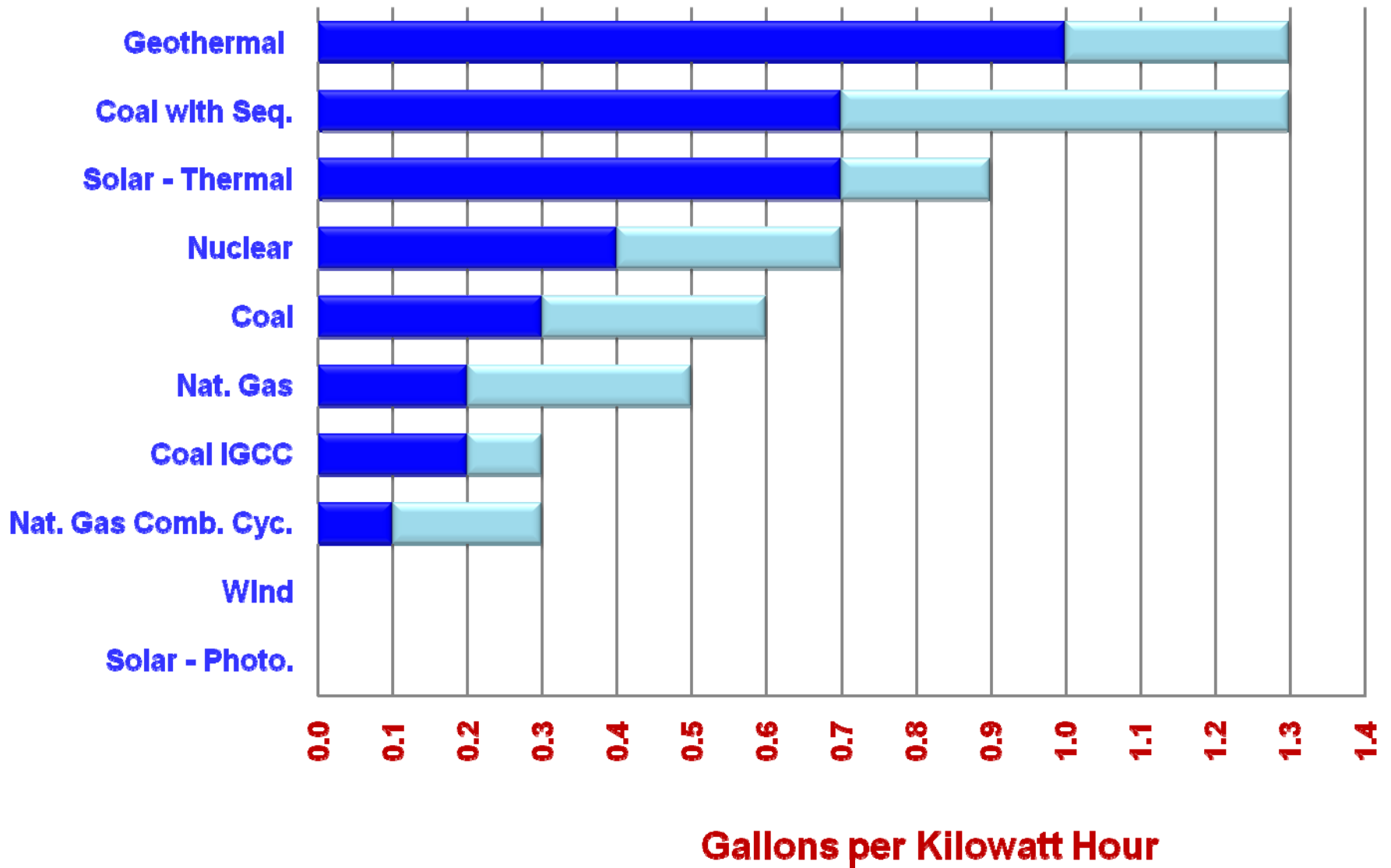


Withdrawal vs. Consumption

USGS 2000



Water Consumed per Kilowatt-hour



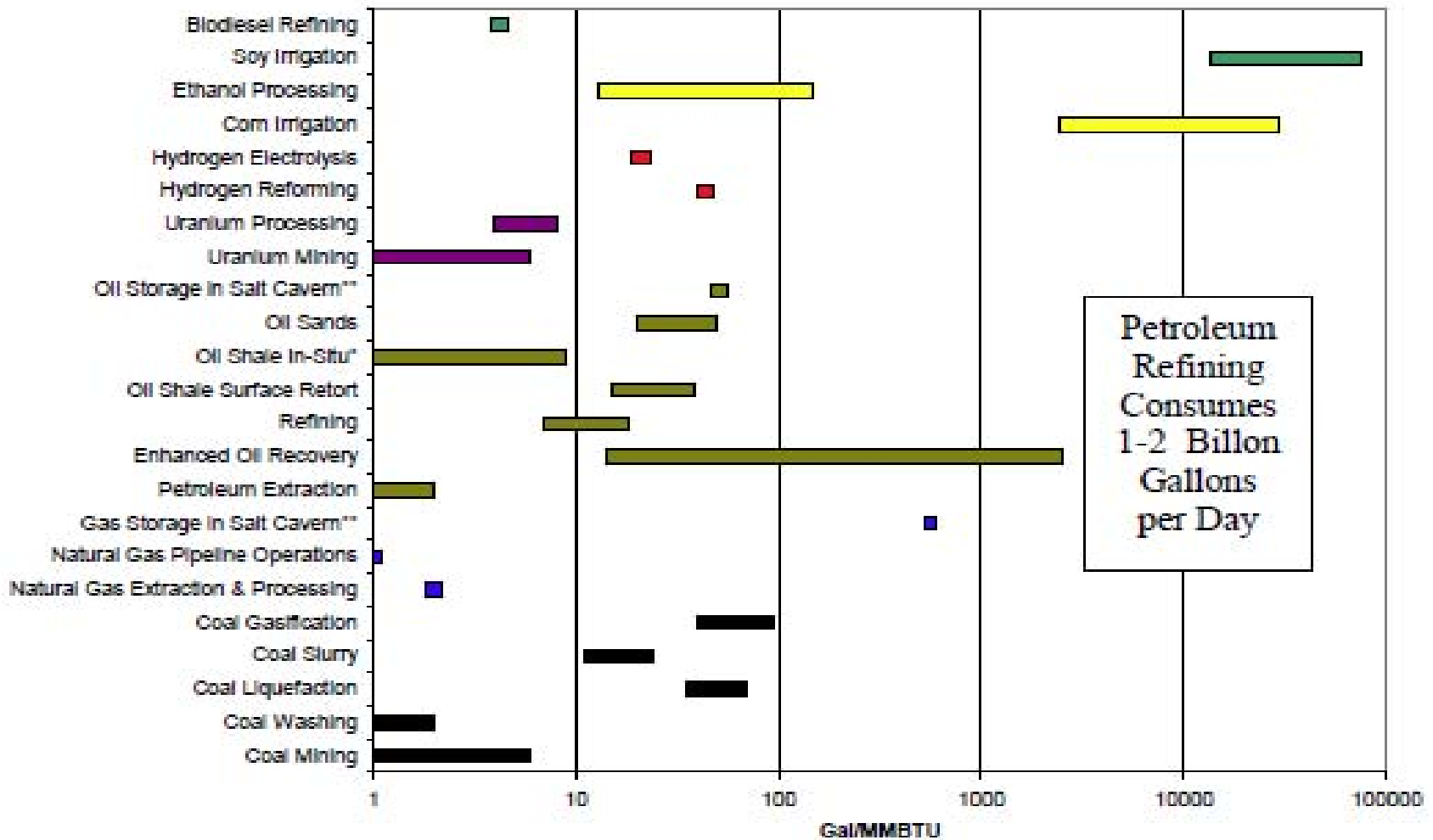


Figure V-4. Water Consumption Per-Unit-Energy and Current Water Use for Fuel Extraction and Processing
 See Appendix B for Data References

The Hydrogen Economy

Hydrogen will be
made from

water and electricity

Solar Thermal Power Plants

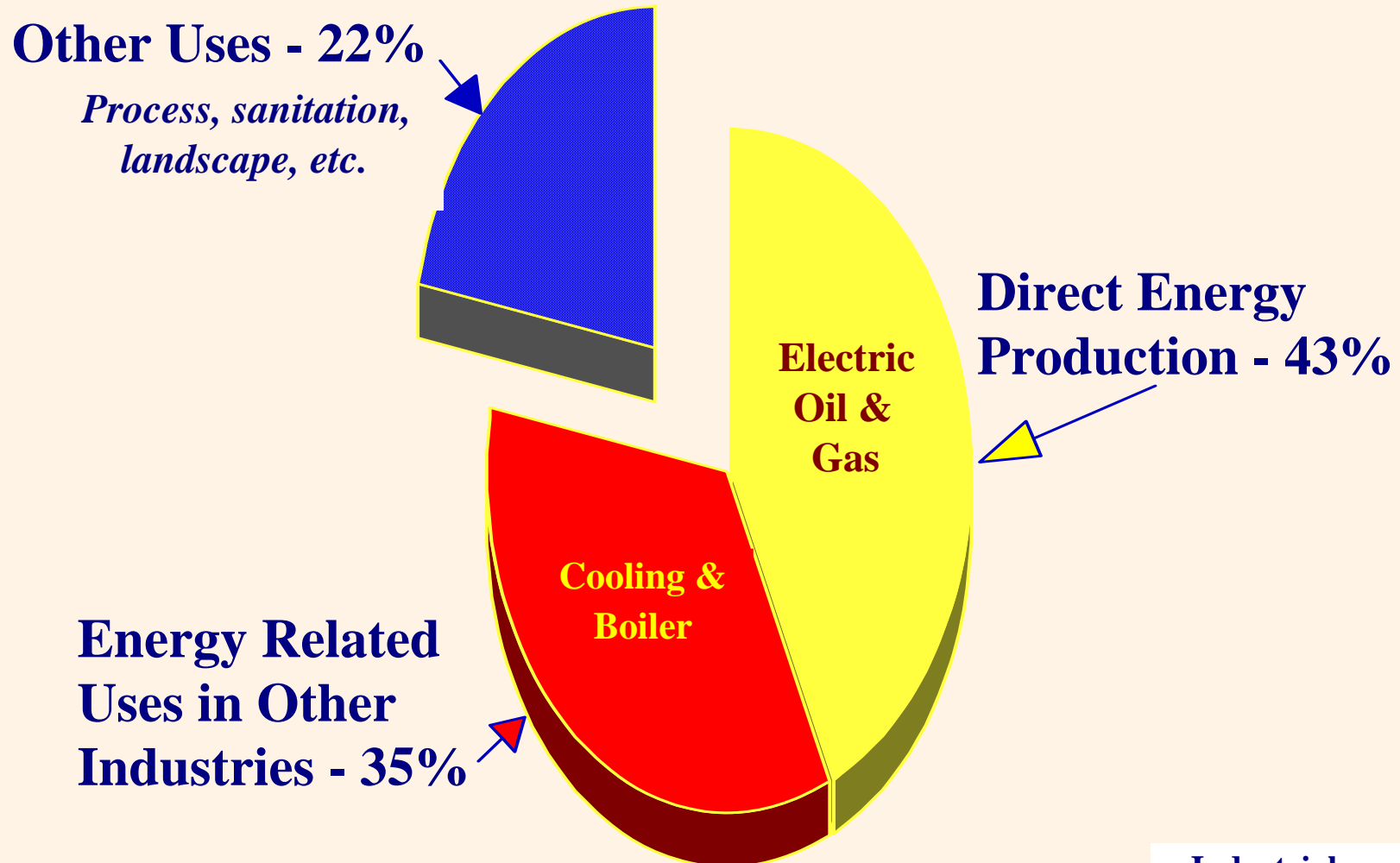
These can
require
millions of
gallons a day!



<http://www.solarthermalworld.org/node/644>

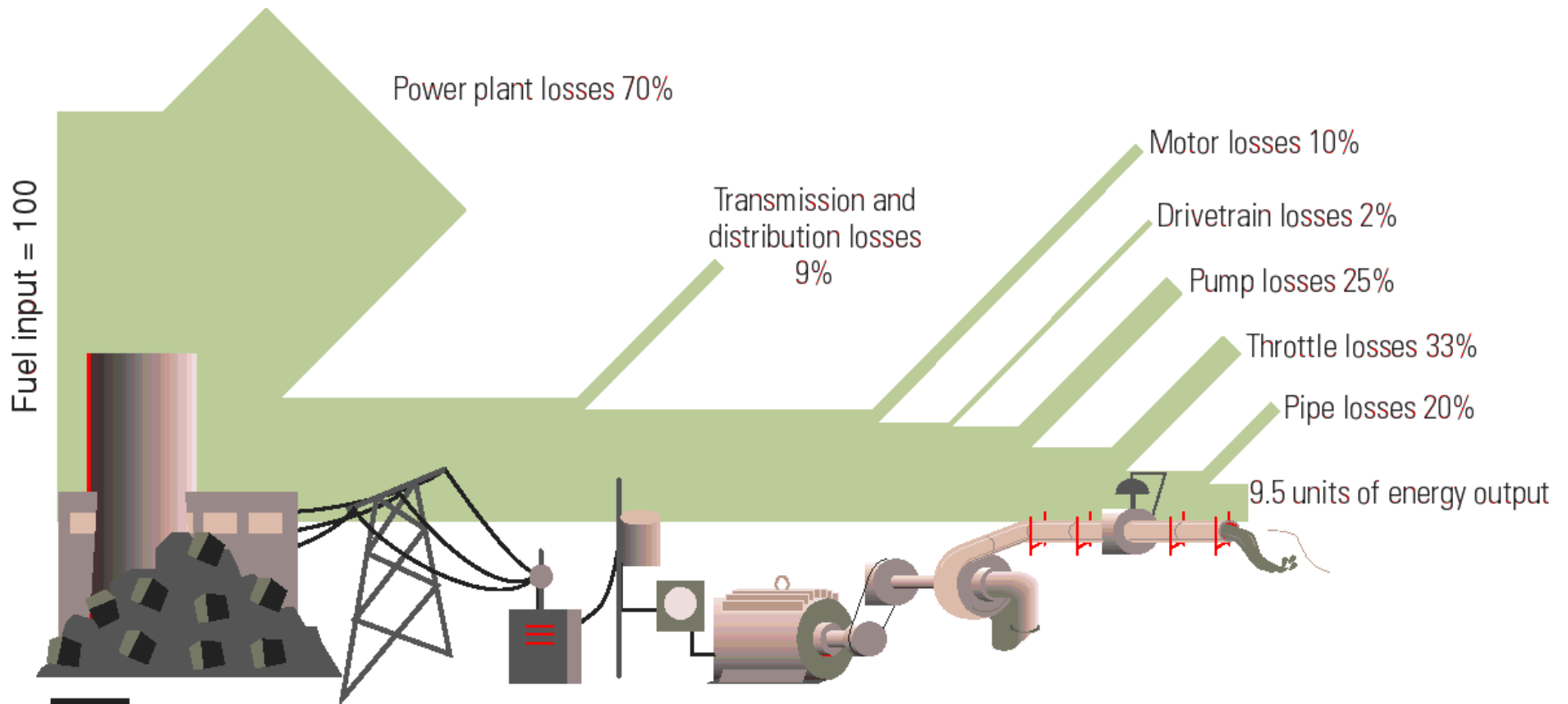
Industrial Water Use in Texas

Energy Related Water Use = 78%

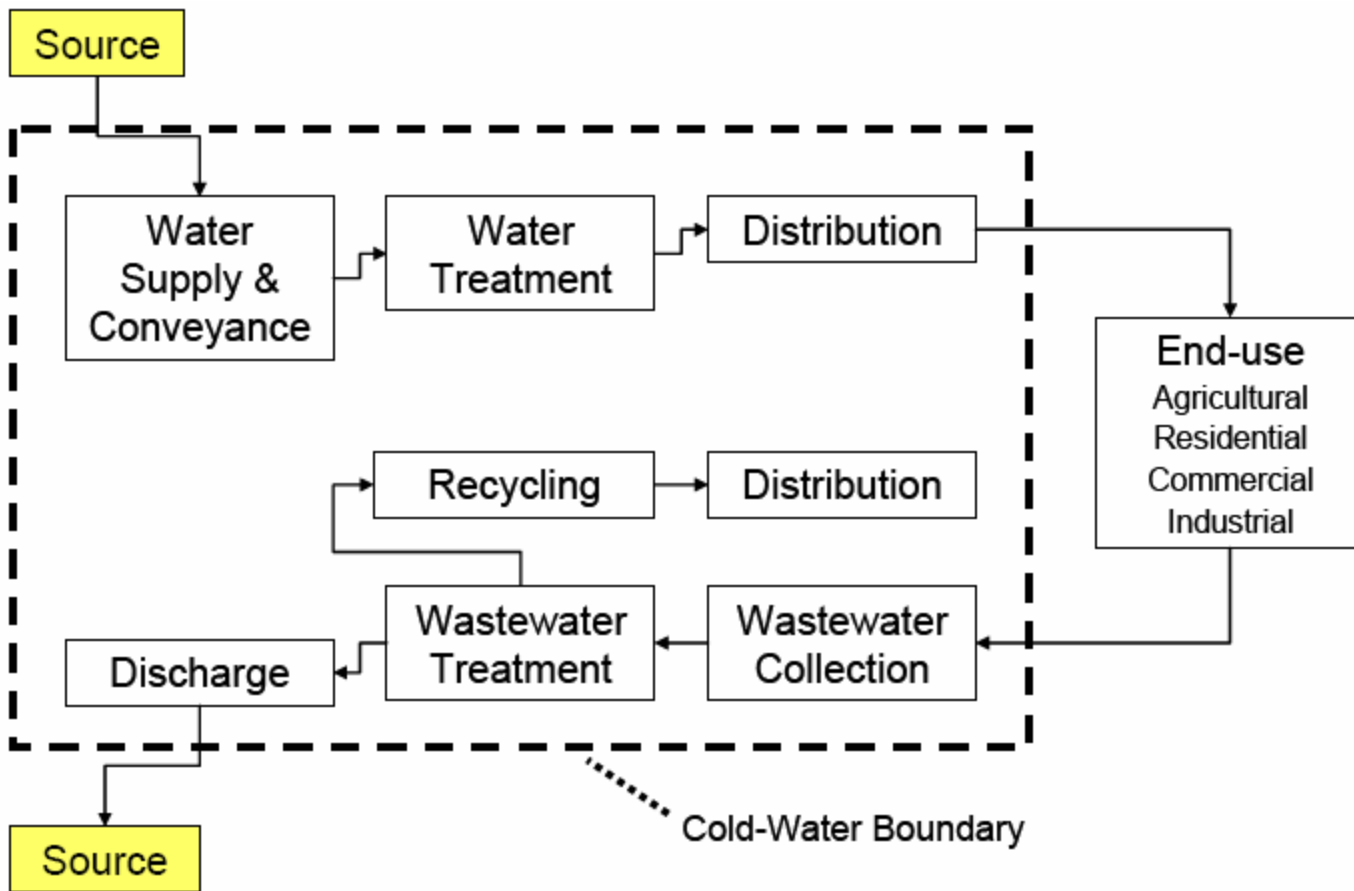


Industrial use is 2.3 million acre-feet a year

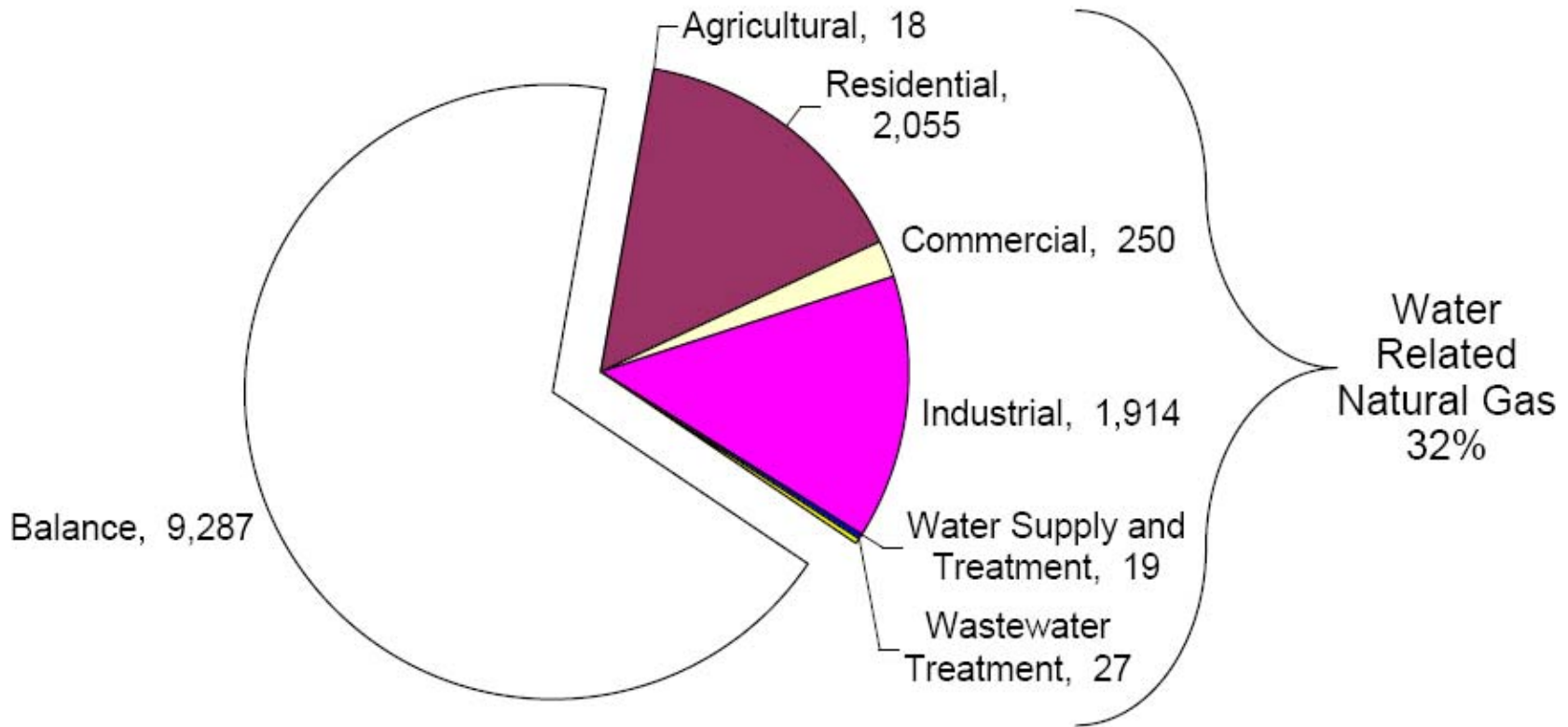
Compounding losses... or savings



From the *Drivepower Technology Atlas*.
Courtesy of E SOURCE, www.esource.com.

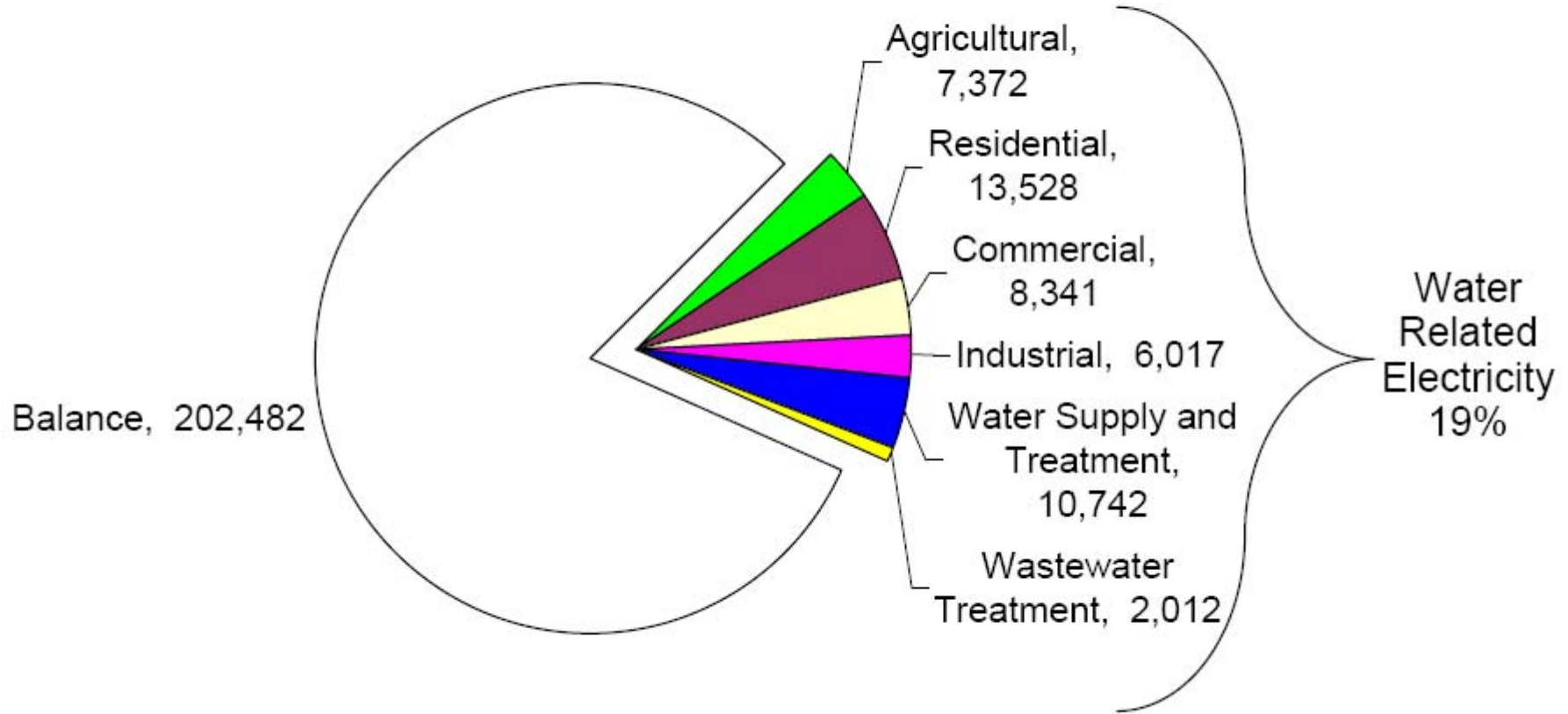


Natural Gas Demand for California's Water System in 2001



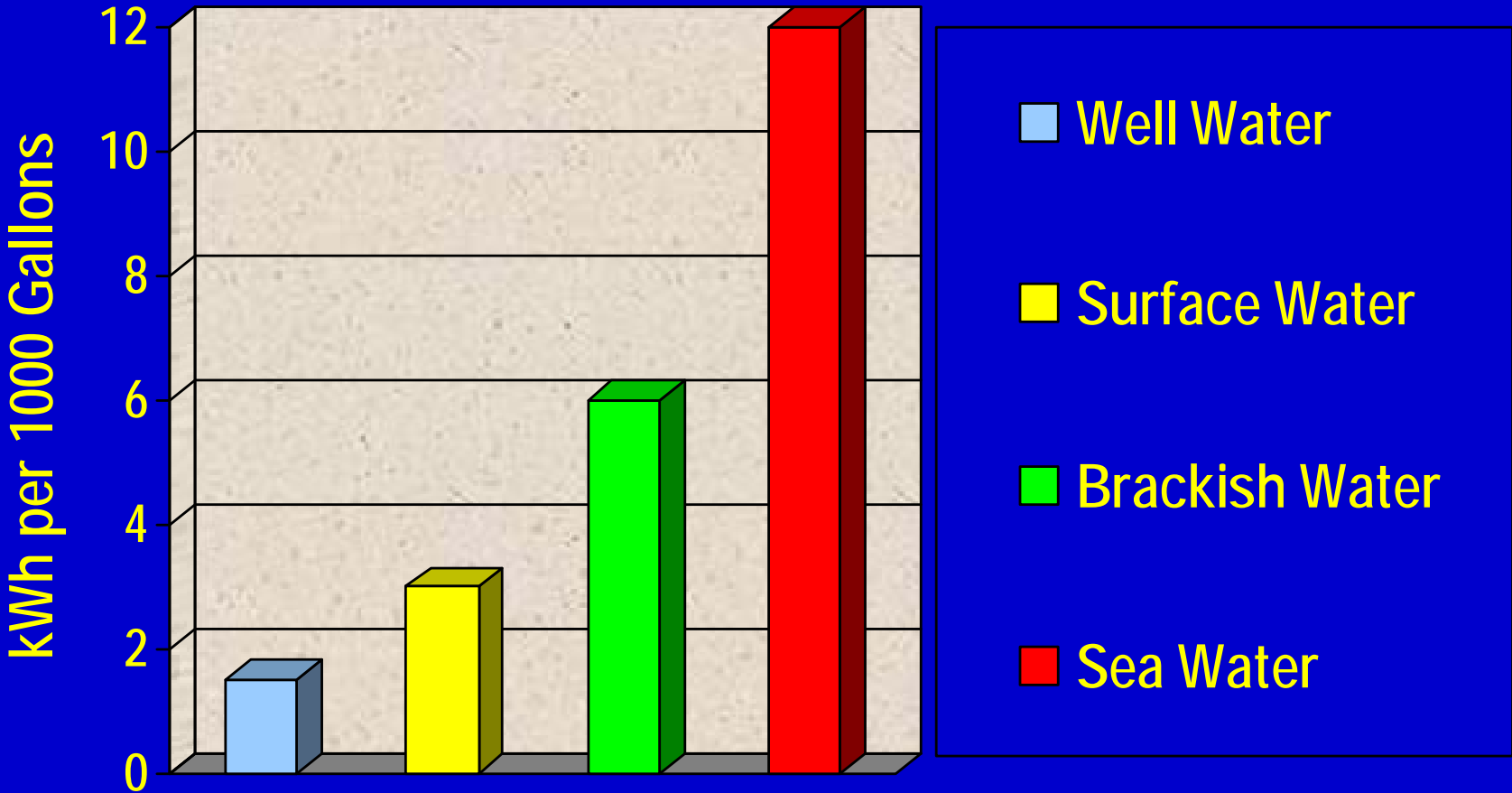
Total Natural Gas Demand in 2001 = 13,571 therms

Electricity Demand for California's Water System in 2001



Total Electricity Demand in 2001 = 250,454 GWh

Energy use per 1000 Gallons of Potable Water Delivered



**Save water – save energy
Save energy – Save Water**

Well most of the time!

Pre-Rinse Spray Valves



More water
Less pressure



Forceful
Spray

Old Spray Valve

- ❖ 4-6 GPM
- ❖ 8-12 Cents/Min.

New Spray Valve

- ❖ ***1.6 GPM***
- ❖ ***3.2 Cents/Min.***

Pre Rinse Spray Valve Savings

Hours of Spray Valve Usage	Water Savings gallons/day	Waste Water Savings gallons/day	Gas Savings therms/day	Annual Dollar Savings
1 hour/day	60 gallons	60 gallons	0.5 therms	\$300 - \$350
2 hours/day	120 gallons	120 gallons	1 therms	\$600 - \$700
3 hours/day	180	180	1.5	\$900 - \$1050

Table shows results based on spray valve water savings of 1 gallon per minute, water cost of \$2.00 per unit (748 gallons), sewer cost of 3.00 per unit (748 gallons), and gas cost of \$1.00 per therm.

Source :Food Service Technology Center

Garbage Disposals vs. Strainers

- **Water Use**
 - Grinders from 2 to 12 gpm
 - Scrap baskets 0.0 gpm
- **Horse Power**
 - Grinders from 1 to 10 hp
 - Scrap baskets 0.0 hp
- **Example**
 - 10 HP
 - 12 Gallons per minute or 720 gallons per hour



Scrap Basket Strainers



Old System



Scrap Basket

Garbage Disposal Comparison

	Grinder	Salvajor	Pulpier	Strainer Basket
Solids to Sewer	Yes	No	No	No
Recirculate	No	Yes	Yes	No
Strain Solids	No	Yes	Yes	Yes
Compost Prod.	No	Yes	Yes	Yes
Solid Waste Prod.	No	Yes	Yes	Yes
Flow Restrictor?	Yes	No	No	N/A
HP	1-10	0.75-7.5	3-10	0
GPM (Potable only)	3-8	1-2	1-2	0
Sluice Trough GPM	2-15	2-15 <i>recirculation?</i>	2-15 <i>recirculation?</i>	0

Commercial Examples Using Both Water & Energy

- ✓ Pre-rinse Spray Valves
- ✓ Garbage Disposals
- ✓ Commercial Dishwashers
- ✓ Boilerless Steamers
- ✓ X-Ray Film Development
- ✓ Vacuum Pumps

Embedded Energy

<i>MEASURE</i>	Savings per Measure Gal./Day	Water Savings Gal./Year	Water Energy Savings kWh/Yr.	Customer * Energy Savings kWh/Yr.	Total Energy Savings kWh/Yr.
Residential Examples					
Toilet Rebates	25	9,125	25		25
Clothes Washer Rebates	15	5,475	15	600	615
Commercial Examples					
Dental Vacuum Pumps	720	262,800	717	1,750	2,467
Pre-rinse spray valve (restaurant)	200	73,000	199	4,370	4,570
Remove Garbage Grinder	400	146,000	399	8,741	9,139
* Energy used to operate the equipment					

Boilerless Steamers



- 90% less water
- 75% less energy
- No water hookup
- No sewer hookup
- No vent

Dental Vacuum Pumps

- Dry systems eliminate water use and are more energy efficient

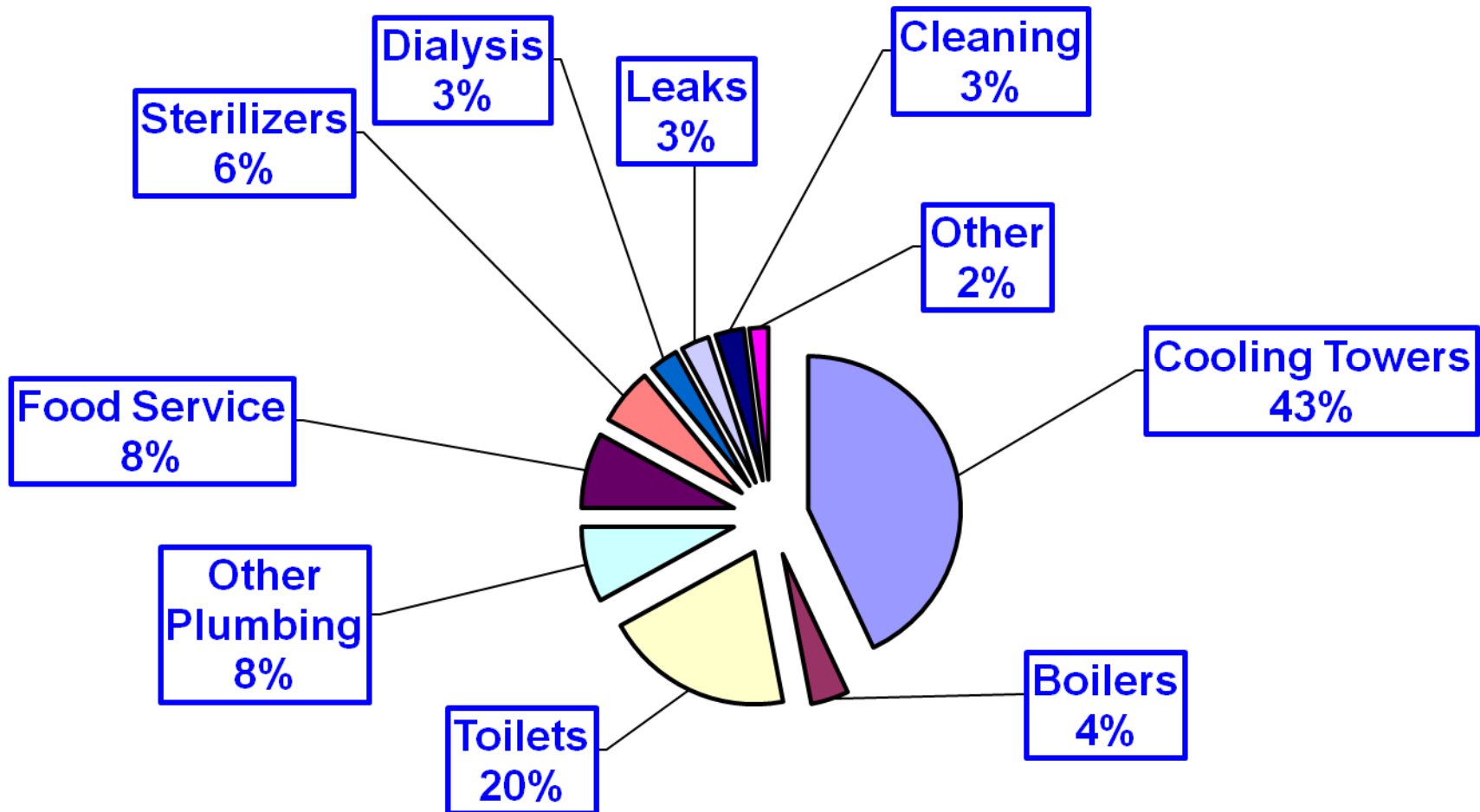


Old Liquid Ring Pump New Dry Vacuum Pump



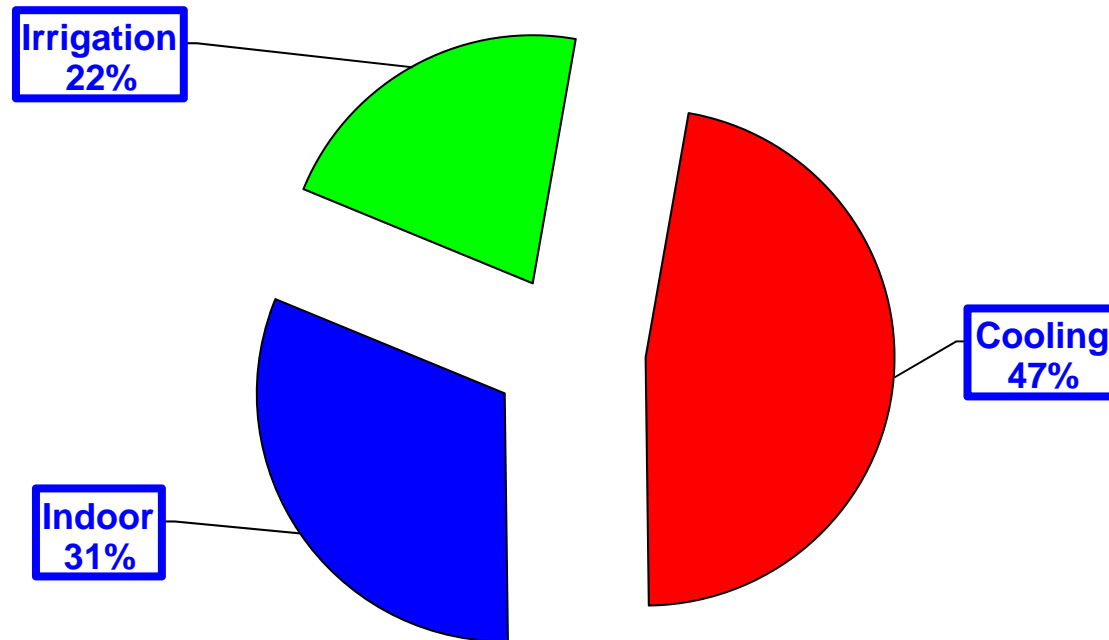
**So what does all of this mean
to an ASHRAE member?**

A Large Hospital in Florida

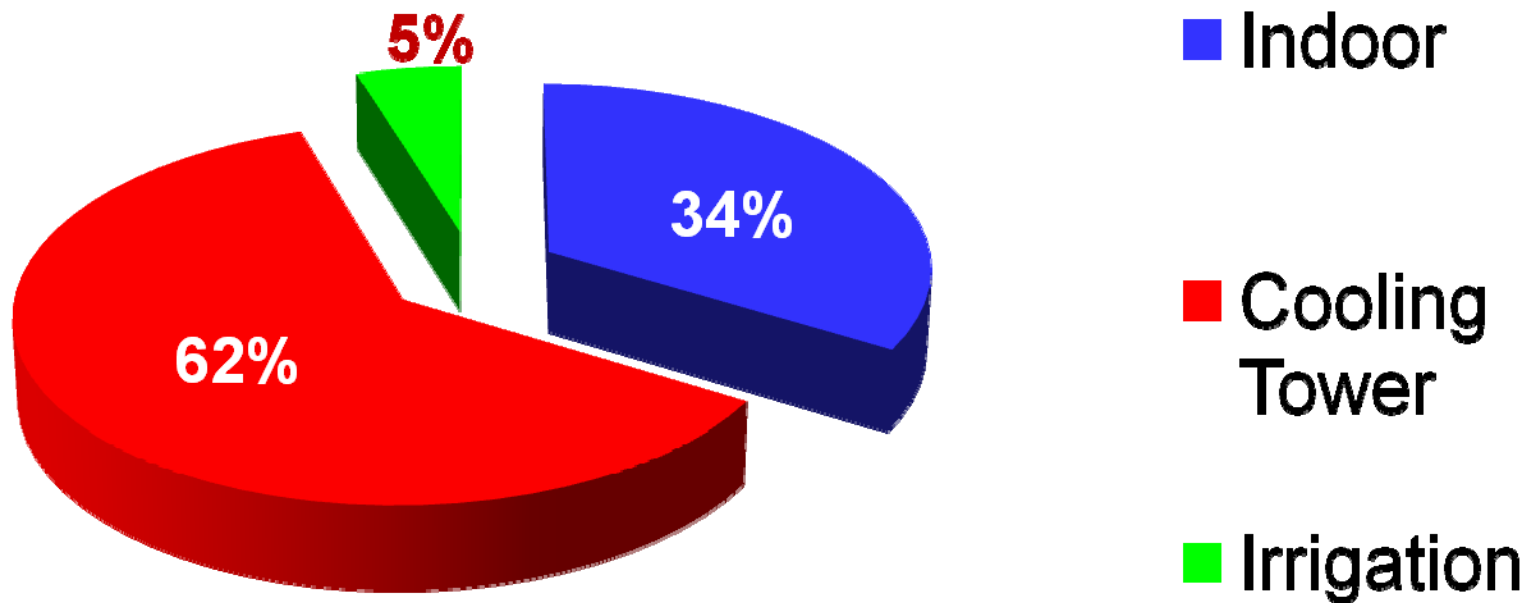


Annual Water Use

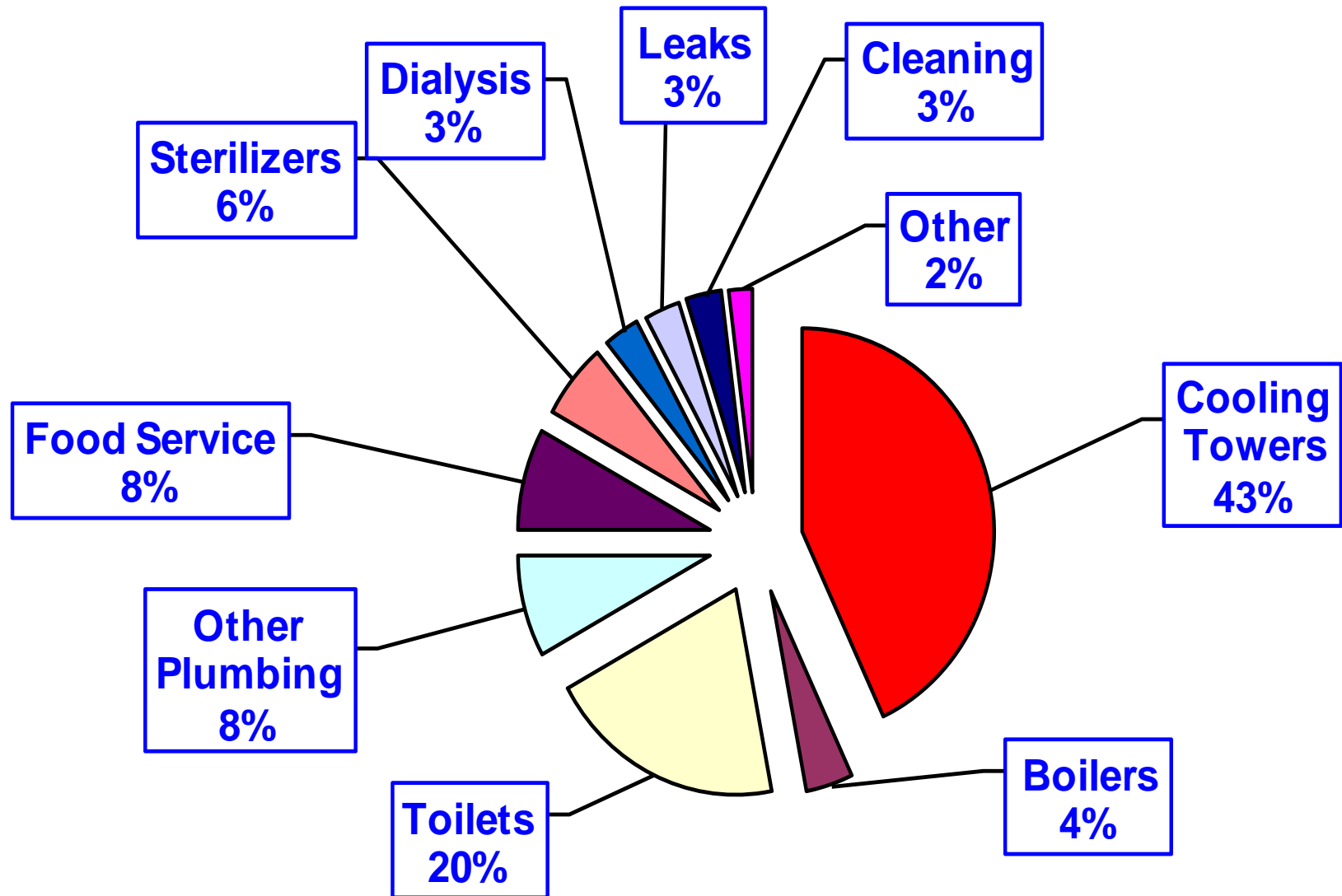
for a 10 Story Office Building in South West



2000 AWWA Grocery Store Study



A Large Hospital in South East



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 25% load factor for the year.
- Cooling tower makeup is 2.25 gallons per ton hour.

The Impact

- **Peak day use – 24,300 gallons a day**
- **Annual use – 3.7 million gallons a year**
- **Capital cost of water system to provide peak demand - \$48,600**
- **Cost per ton of capacity - \$65 per ton at a capital cost for water supply of \$2.00 per gdc.**

Cooling towers and Energy Savings

- Chillers now achieve 0.55 kWh/ton-hour
- With cost of water circulation (tower and chilled water) added it is about 0.65 kWh/ton-hour for the CWS
- Best DX systems – 0.95 kWh/ton-hour, but limited in size etc.
- Geothermal systems beat DX and in some cases chilled water systems
- Other systems like VRV report higher efficiencies than DX but below CWS

DX vs. CWS

- **CWS saves 0.3 kWh/ton hour which is equal to 3.0 to 3.5 cents per ton hour.**
- **CWS uses 2.25 gallons of water per ton-hour.**

Commercial Water and Sewer Rates for Selected Cities

City	Approximate* Water Rate (\$/1,000 Gal.)	Approximate* Sewer Rate (\$/1,000 Gal.)	Combined Rates (\$/1,000 Gal.)
Seattle, WA	\$6.02	\$11.89	\$17.90
Austin, TX	\$4.40	\$7.23	\$11.63
Miami, FL	\$4.00	\$5.29	\$9.29
New York, NY	\$3.49	\$5.55	\$9.04
Los Angeles, CA	\$3.88	\$4.08	\$7.96
Minneapolis, MN	\$3.89	\$3.49	\$7.38
Pittsburg, PA	\$4.89	\$2.30	\$7.19

** Rates based on most current data available from the above utility's web sites. Some rates reflect an average of multi-tier or seasonal rates.*

Cents per Ton Hour for Selected Cities

(2.25 gallons per ton hour)

City	Water	Wastewater	Total
Seattle, WA	1.35	2.68	4.03
Austin, TX	0.99	1.63	2.62
Miami, FL	0.90	1.19	2.09
New York, NY	0.79	1.25	2.03
Los Angeles, CA	0.87	0.92	1.79
Minneapolis, MN	0.88	0.79	1.66
Pittsburg, PA	1.10	0.52	1.62

** Rates based on most current data available from the above utility's web sites. Some rates reflect an average of multi-tier or seasonal rates.*

Cost of New Water and Wastewater Capacity



\$/Gal. – Day of Capacity (qdc)

- **Conventional Fresh Water –**
\$0.8 to \$4.00
- **Desalinization –**
\$5 - \$8
- **Wastewater –**
\$ 1 - \$5
- **Total**
\$0.8 - \$13.00

Other Costs

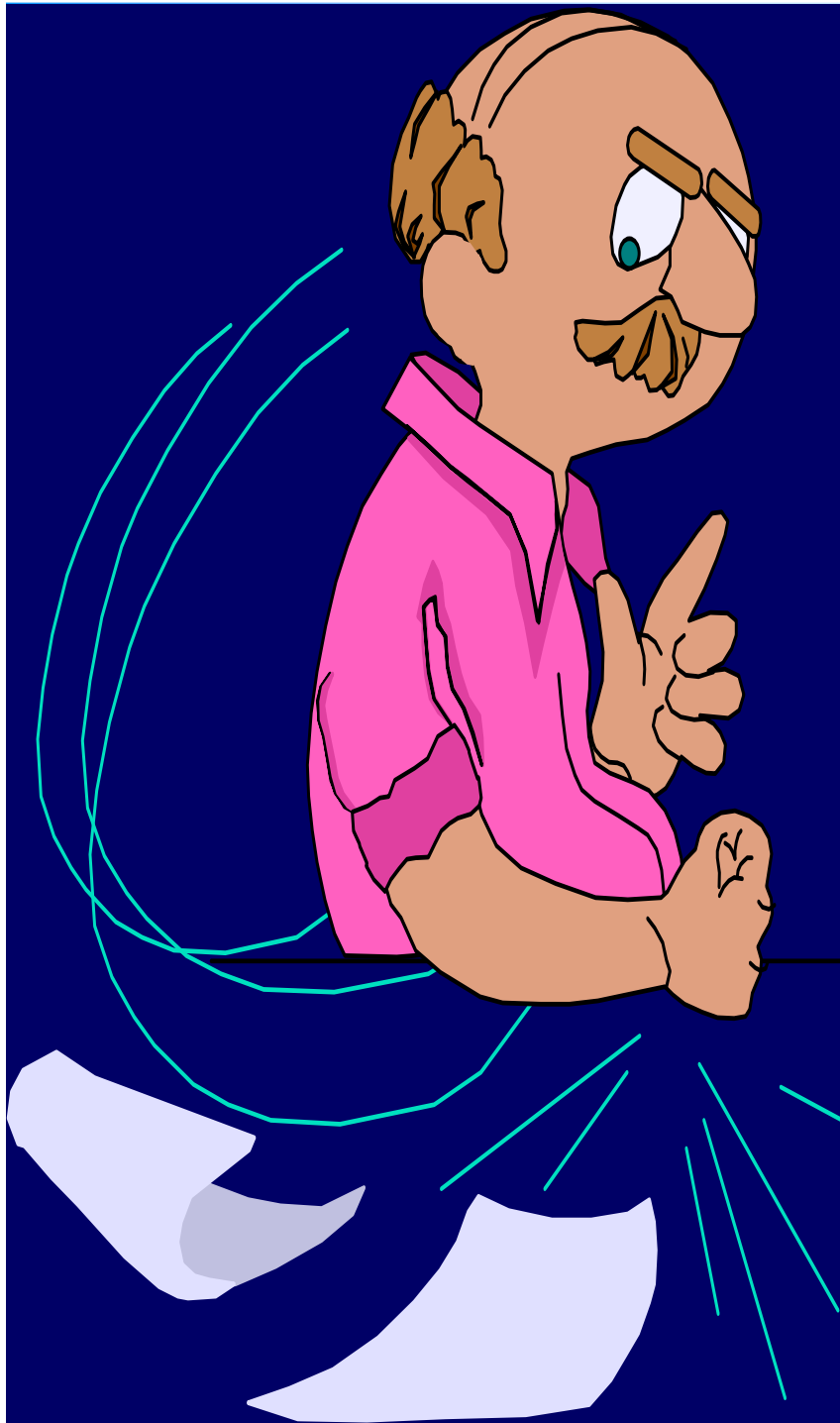
- Treatment Costs – \$0.25 to \$8.00 per 1000 gallons 0.05 to 1.7 cents per ton hour.
- Labor costs and contract costs???
- Environmental costs beyond water use – TMDL, Salinity, Pretreatment, ??

Alternate Cooling Methods

- **Geothermal heat pump systems;**
- **Variable refrigerant volume systems**
- **Direct expansion systems**
- **Hybrid cooling towers**
- **Cooling ponds (perhaps in conjunction with stormwater management)**

Alternate Sources of Water

- Reclaimed wastewater from municipal source
- Alternate on-site sources
 - On-site wastewater reclamation system
 - A/C condensate
 - Foundation drain water
 - Rain and storm water



It's

MY

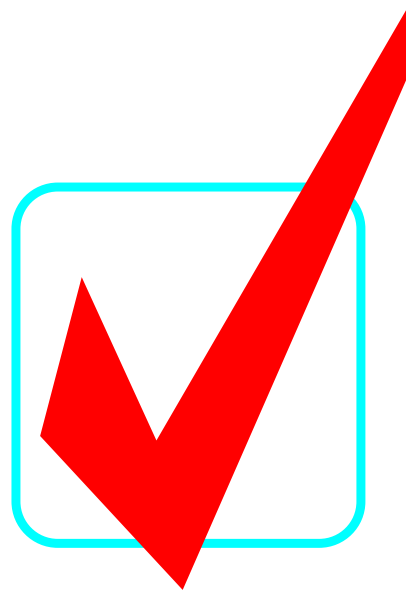
SEWAGE

and *you*

can't have it

!!!!

The



End