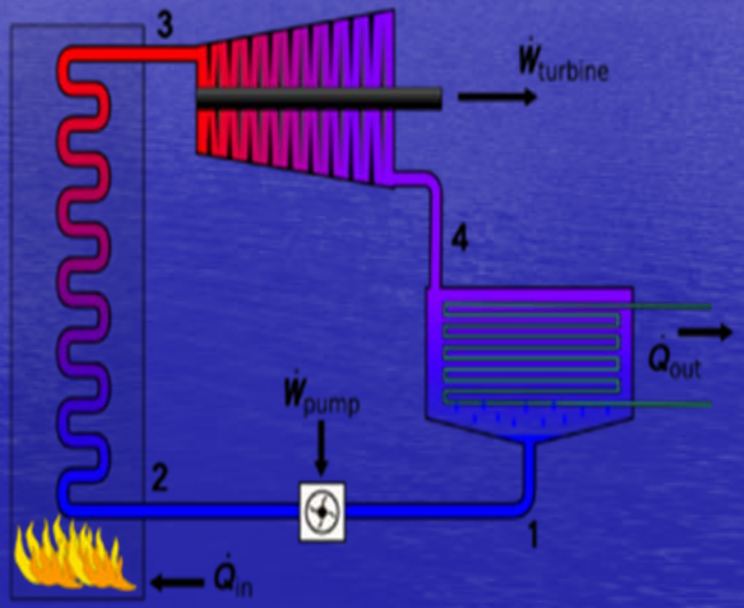
Blue Ribbon Panel Cooling Tower Discussion

Arizona Public Service, Salt River Project, Tucson Electric Power

February 25, 2010

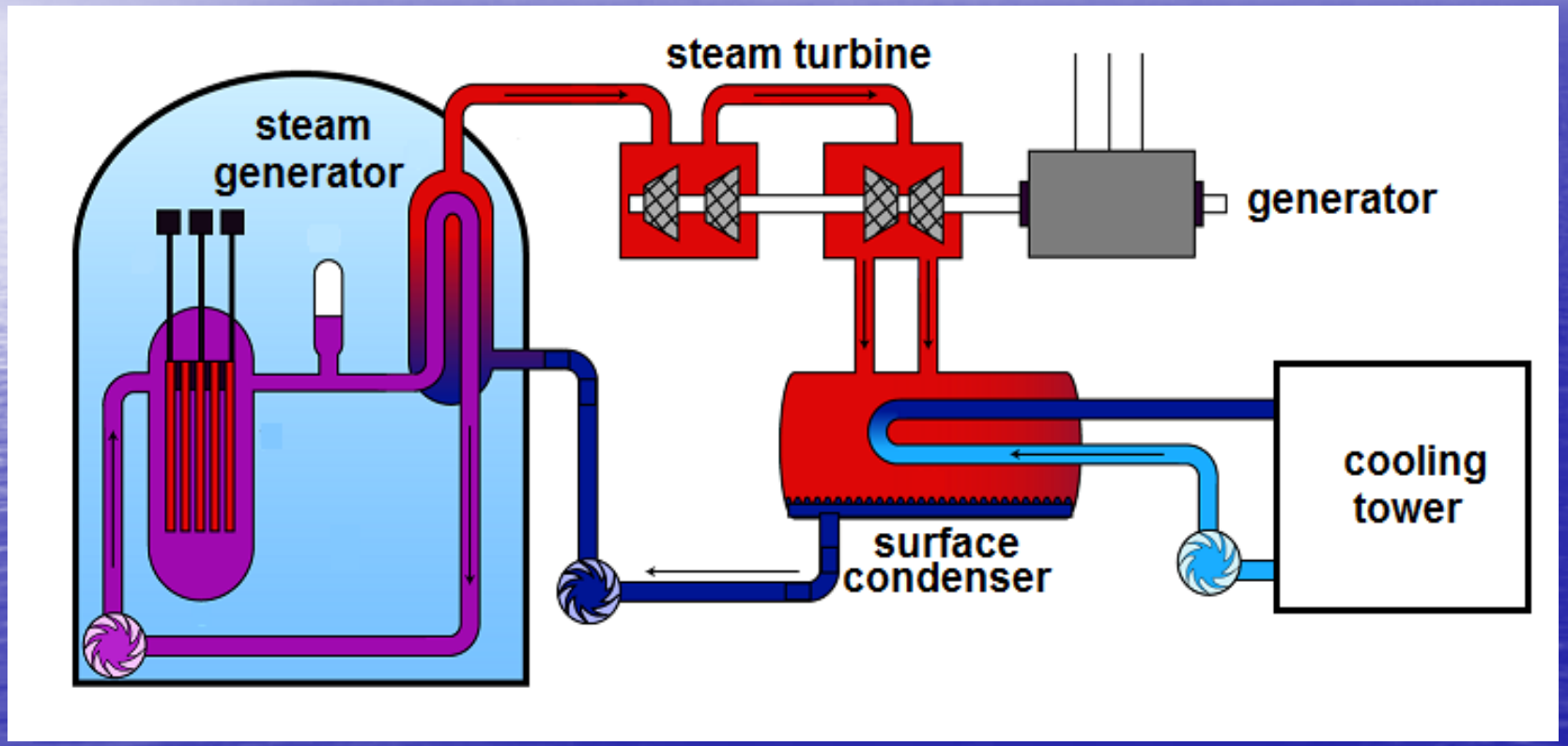
Rankine Steam Cycle

1. Liquid is pumped to a heat source
2. Liquid is heated by external heat source to become a dry saturated vapor
3. Vapor expands through turbine which turns a generator and produces power
4. Vapor is re-condensed returning to liquid state



Nuclear Plant Water Use

Secondary Loop

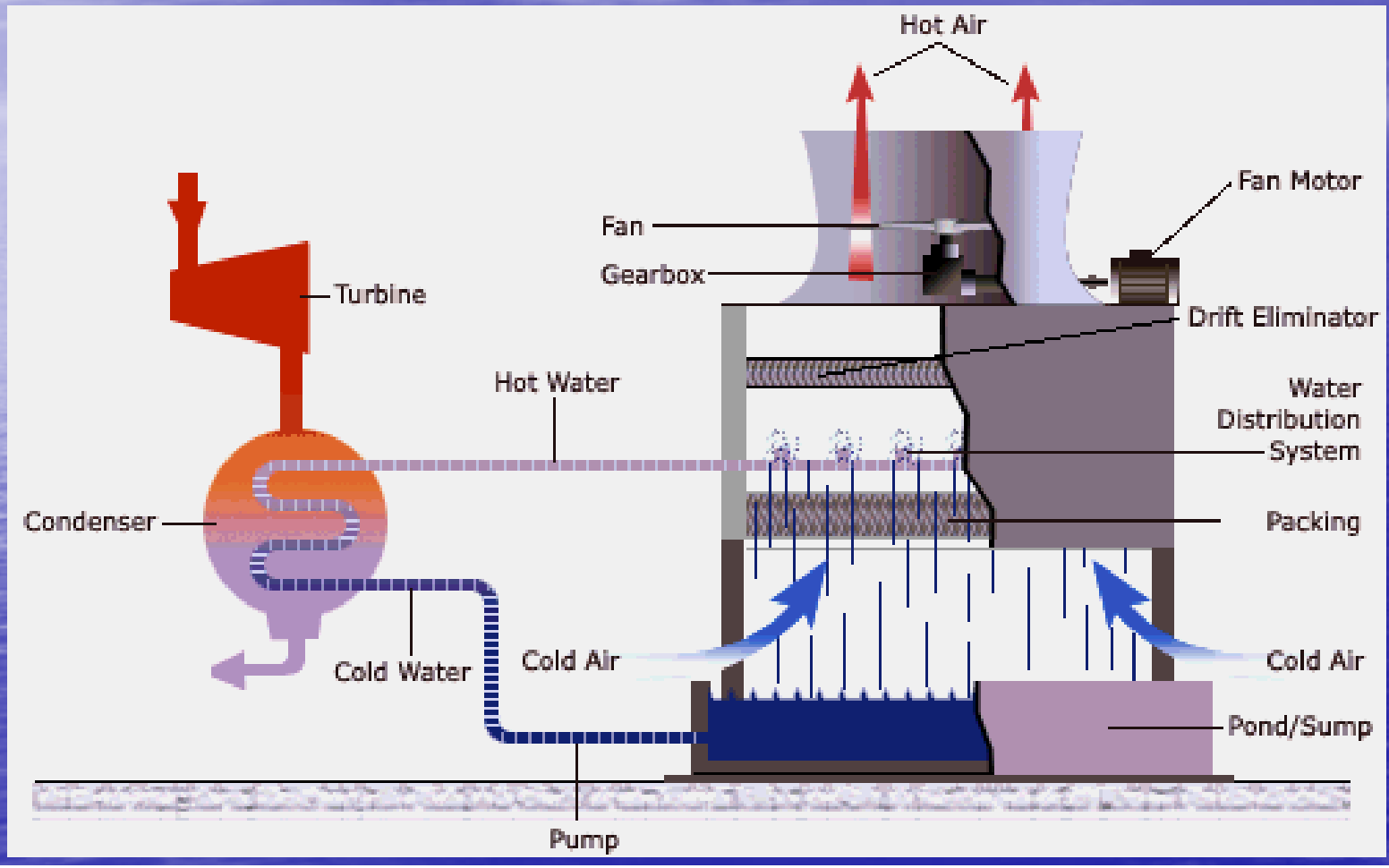


Primary Loop

Tertiary Cooling Loop

3

Mechanical Draft Cooling Tower



Mechanical Draft Towers → wet cooling standard for power plants

Cooling Tower Alternatives

100% WET COOLING:

- Lowest cost solution
- Highest net generation
- Lowest parasitic power consumption
- Smallest footprint
- Highest annual water use

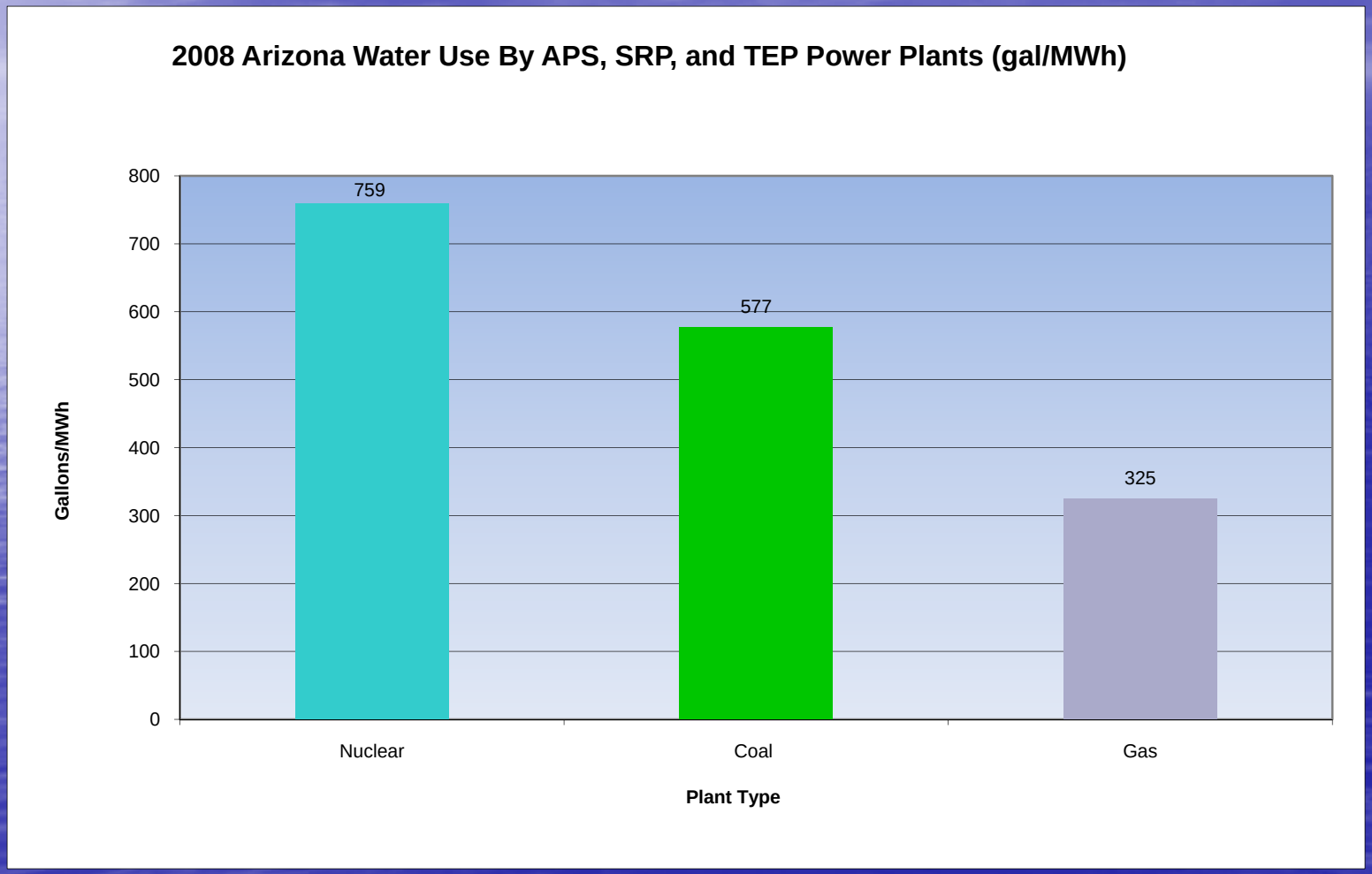
Cooling Tower Alternatives

100% DRY COOLING

- Performs best in cool, humid climate
- Increased turbine back pressure is required
  – makes retrofits difficult
- Highest life cycle cost – highest parasitic load
- Highest new construction capital cost
- Lowest net generation - particularly impacted during summer when generation is most needed
- Major advantage: 0% water usage is possible

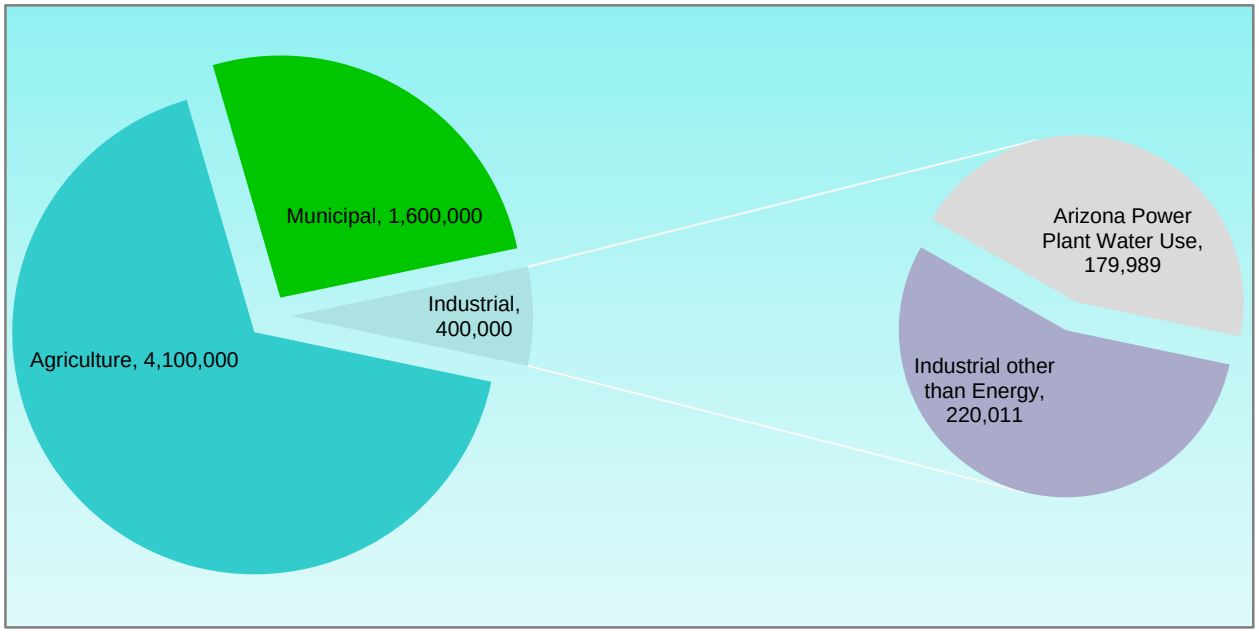
Wet and Dry Combination (hybrid)

Power Plant Water Usage



Water Use

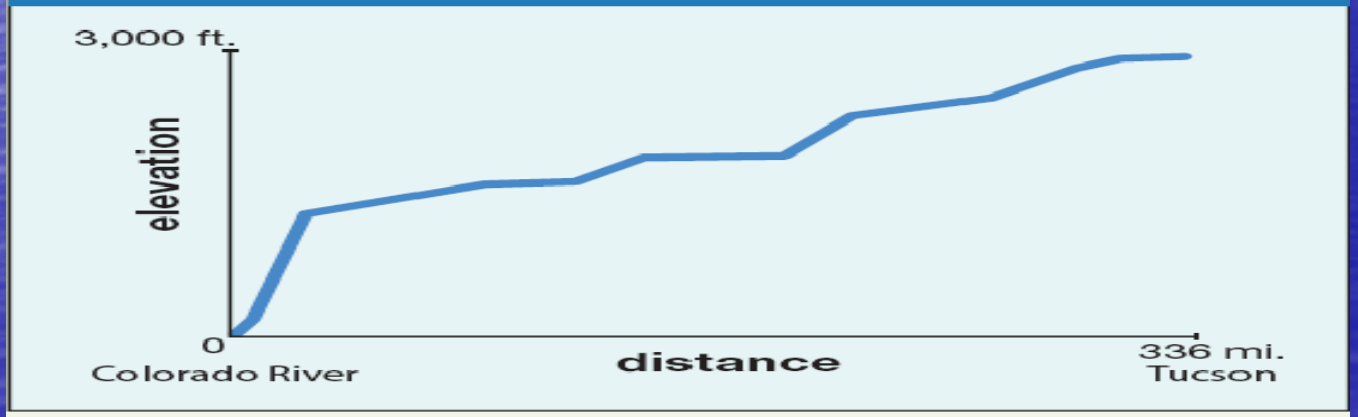
2006 Arizona Water Use and 2008 Arizona Power Plant Water Use



Power Required to Deliver Central Arizona Project Water in Arizona

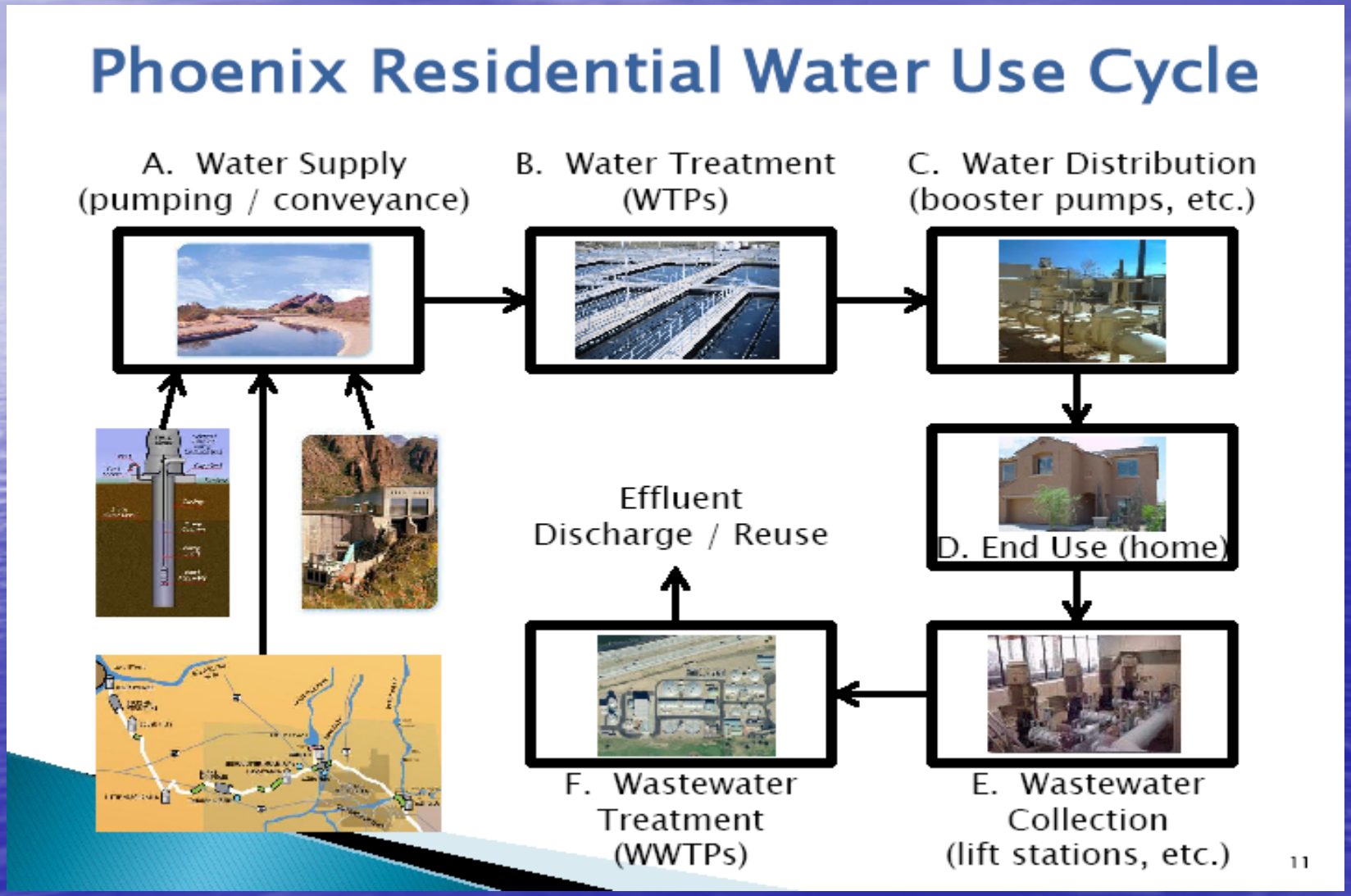
- Largest electricity use in the state at 2.8 million MWh's

CAP Canal

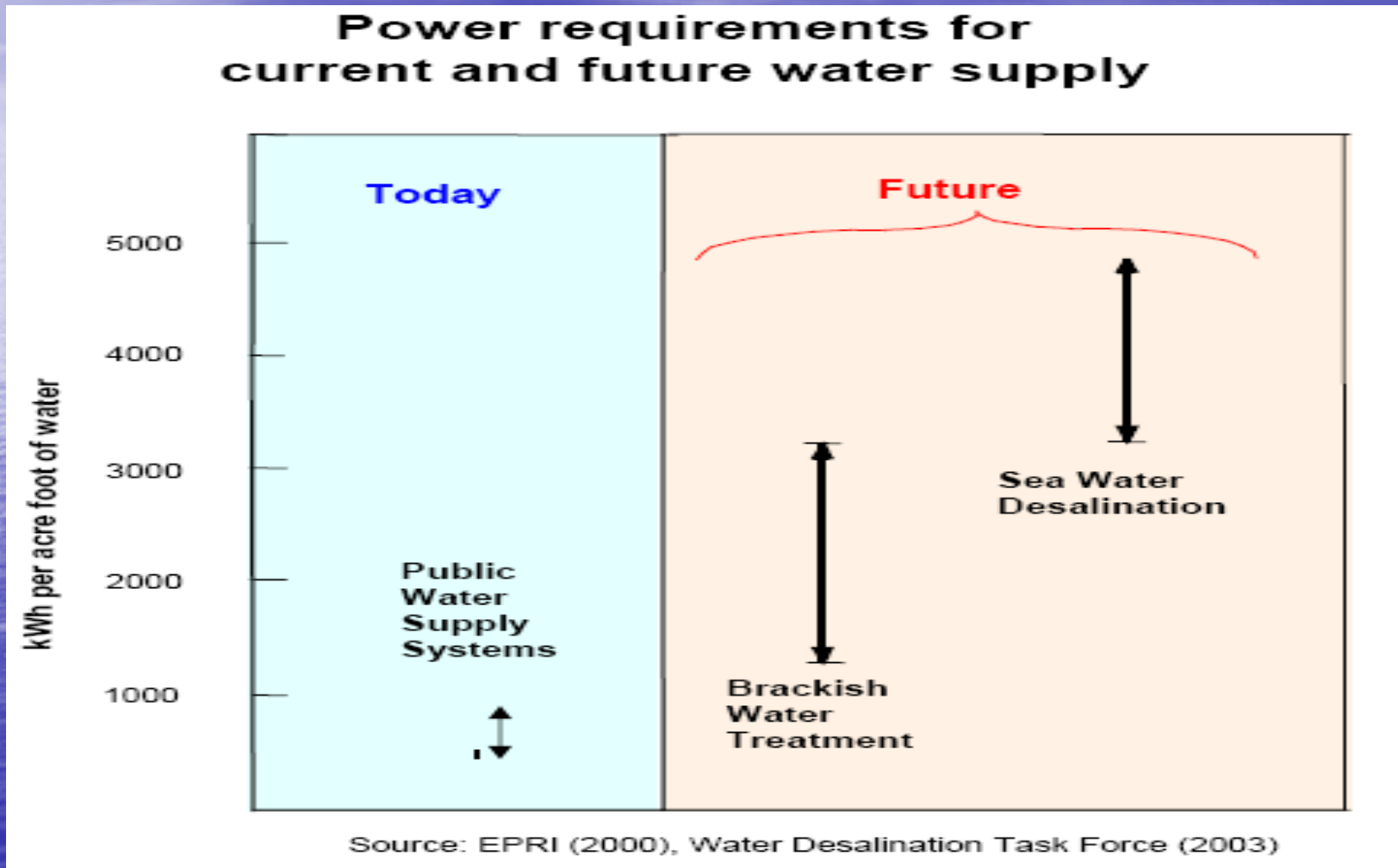


3200 kWh to pump one acre-foot of CAP water from the Colorado River to Tucson.

Water Use Cycle

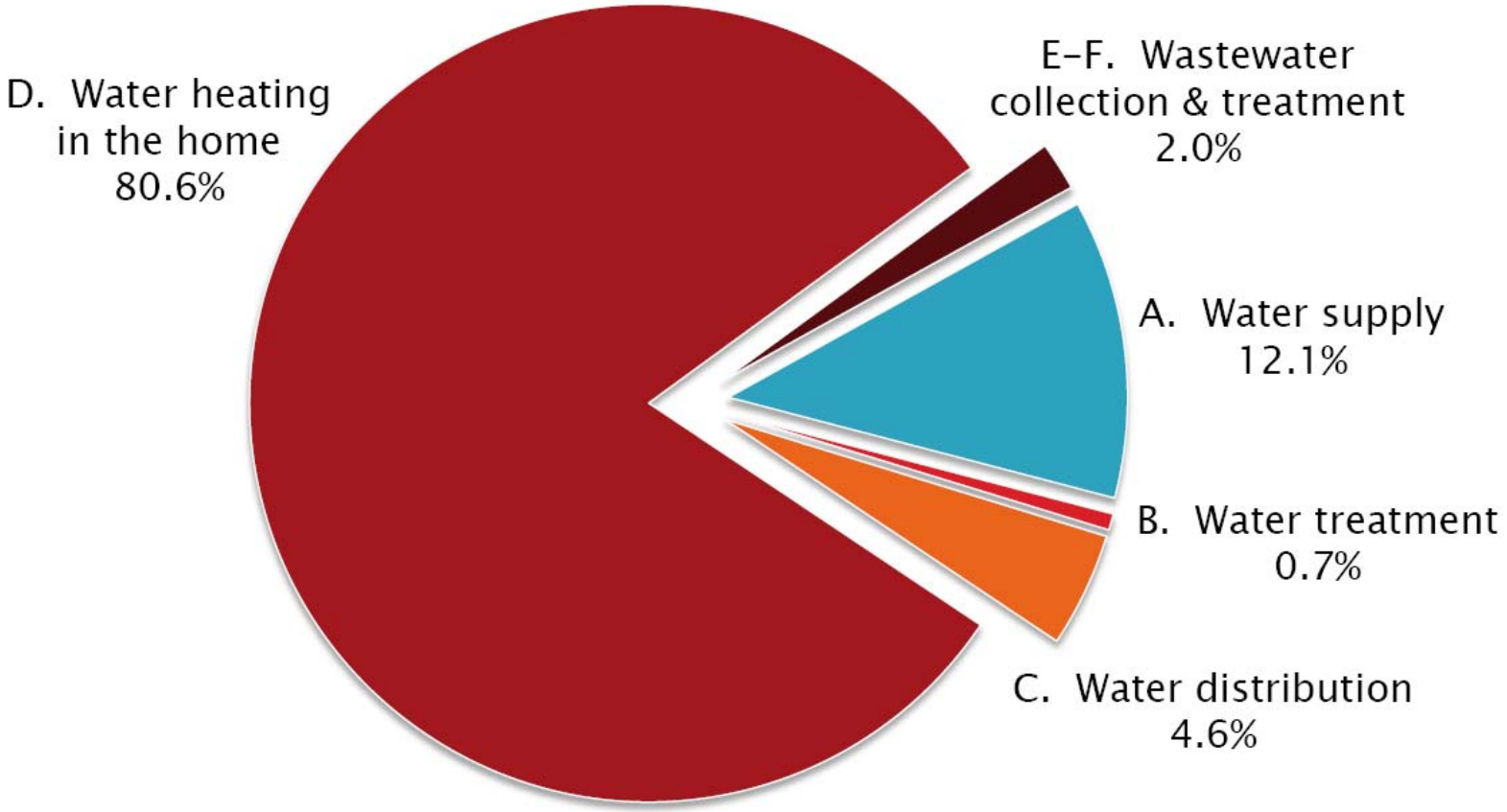


kWh per Acre Foot of Water



Sandia National Laboratories

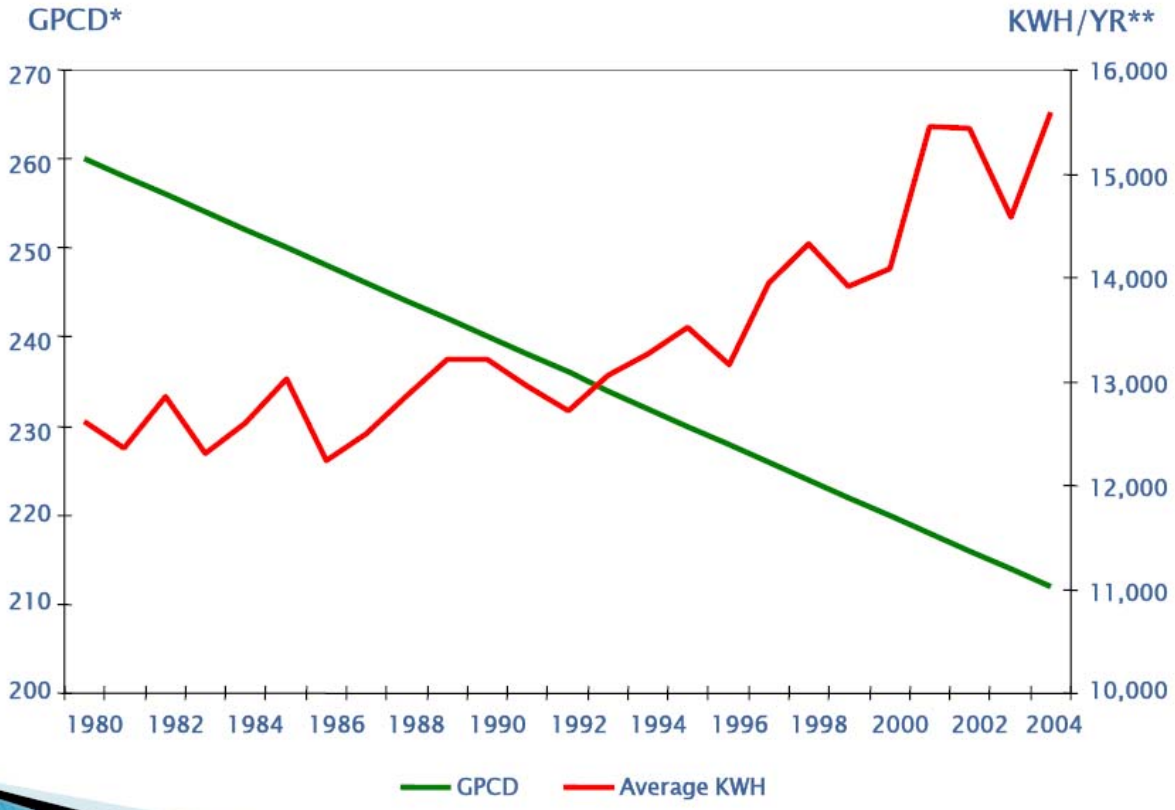
Electricity Embedded in the Water Use Cycle



Over 80% *of the electricity use and carbon emissions for the* ***entire*** *residential (potable) water use cycle can be attributed to* ***water heating*** *in the home.*

Water and Energy Conservation

Water use is declining while energy demand continues to grow



* gallons per capita per day, City of Phoenix

** SRP average annual residential usage

Looking Forward

- **Water and Energy are Interrelated - Conservation of one conserves the other**
  - **Promote water/energy conservation**
  - **Identify alternative cooling strategies**
    - **Investigate practical application of wet, dry, or hybrid cooling towers**
  - **Identify alternative cooling water sources**
    - **Right Water For "The Right Use"**
      - **Utilize impaired waters, where practical, and treat those waters to a quality suitable for use as cooling water**
      - **Conserve higher quality waters for use as potable water**
  - **Water and energy providers work collaboratively planning for the future**

Paradigm Shift

This is a
water-saving device!

This is an
energy-saving device!