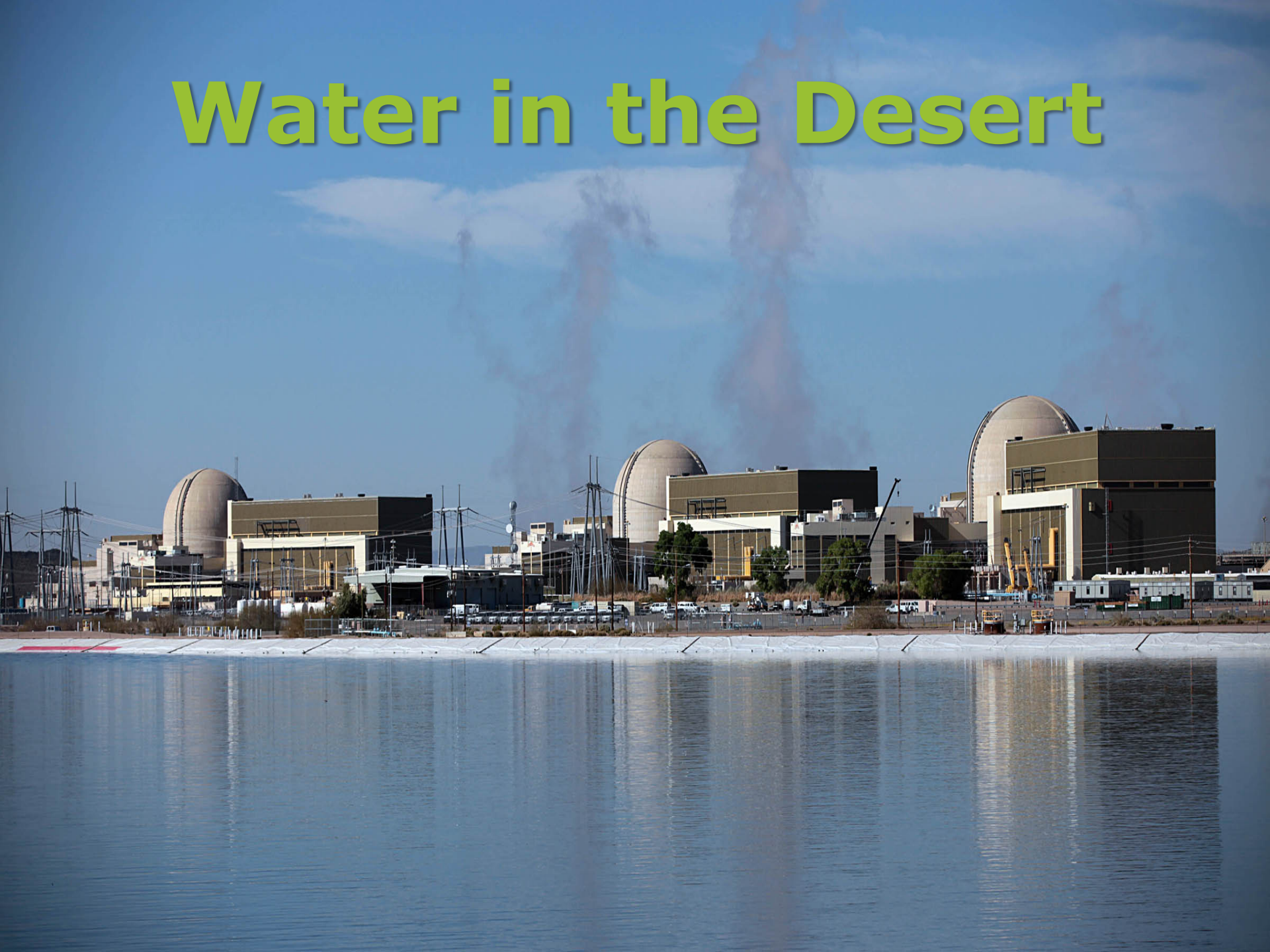




# **Palo Verde and the Water-Energy Nexus**

Reducing Water Use and Cost at the  
Largest Nuclear Plant in the US

# Water in the Desert



# Why Water Resources?

- Traditional power generation requires water... A lot of water!
- Most power plants are located next to a large body of water.
- Palo Verde is located in the middle of the Sonoran Desert.
- Water Resources provides Palo Verde with a body of water.



# Traditional Power Generation Water Usage

Source of Power	Low Gal/MWh	High Gal/MWh
Nuclear	400	800
Coal	500	1000
Natural Gas	100	400
Solar	0	20

\* Does not include water usage for manufacturing or mining operations



# Balancing Priorities

- What else do we use water on and not think about?
  - 1 Almond > 1.1 gal
  - 1 lb Beef > 1847 gal
  - 1 pint of Beer > 20 gal
  - 1 Smartphone > 3400 gal
  - 1 Doz Eggs > 636 gal
  - 1 Car > 39,090 gal
  - 1 Ton Steel > 62,000 gal
  - 1 gal of gas > 13 gal



# Water Resources Overview



Palo Verde Water Resources (WR) is a 90 MGD tertiary treatment plant that reclaims treated effluent from the cities of Phoenix, Scottsdale, Tempe, Mesa, Glendale and Tolleson.



# Cooling Water Treatment

Softening of wastewater treatment plant (WWTP) effluent is a necessity. Softening is performed to:

- Minimize scaling potential
- Maximize water use

Scale Forming Constituents	Influent Quality (ppm)	Effluent Quality (ppm)	Cooling Tower Quality (ppm)
Calcium (as CaCO <sub>3</sub> )	200	100	2200
Magnesium (as CaCO <sub>3</sub> )	150	25	750
Silica	20	4	120
Phosphate	10	<1	10
Chloride	375	375	11000
TDS	1000	1000	28000

# Water - How does it get here?

28.5 miles of gravity flow with 100-foot elevation drop, 8 miles pumped flow with 150-foot elevation increase

91<sup>st</sup> Ave  
Wastewater  
Treatment Plant



6 miles  
of 114"  
gravity  
flow  
pipe

22.5 miles of  
96" gravity  
flow pipe

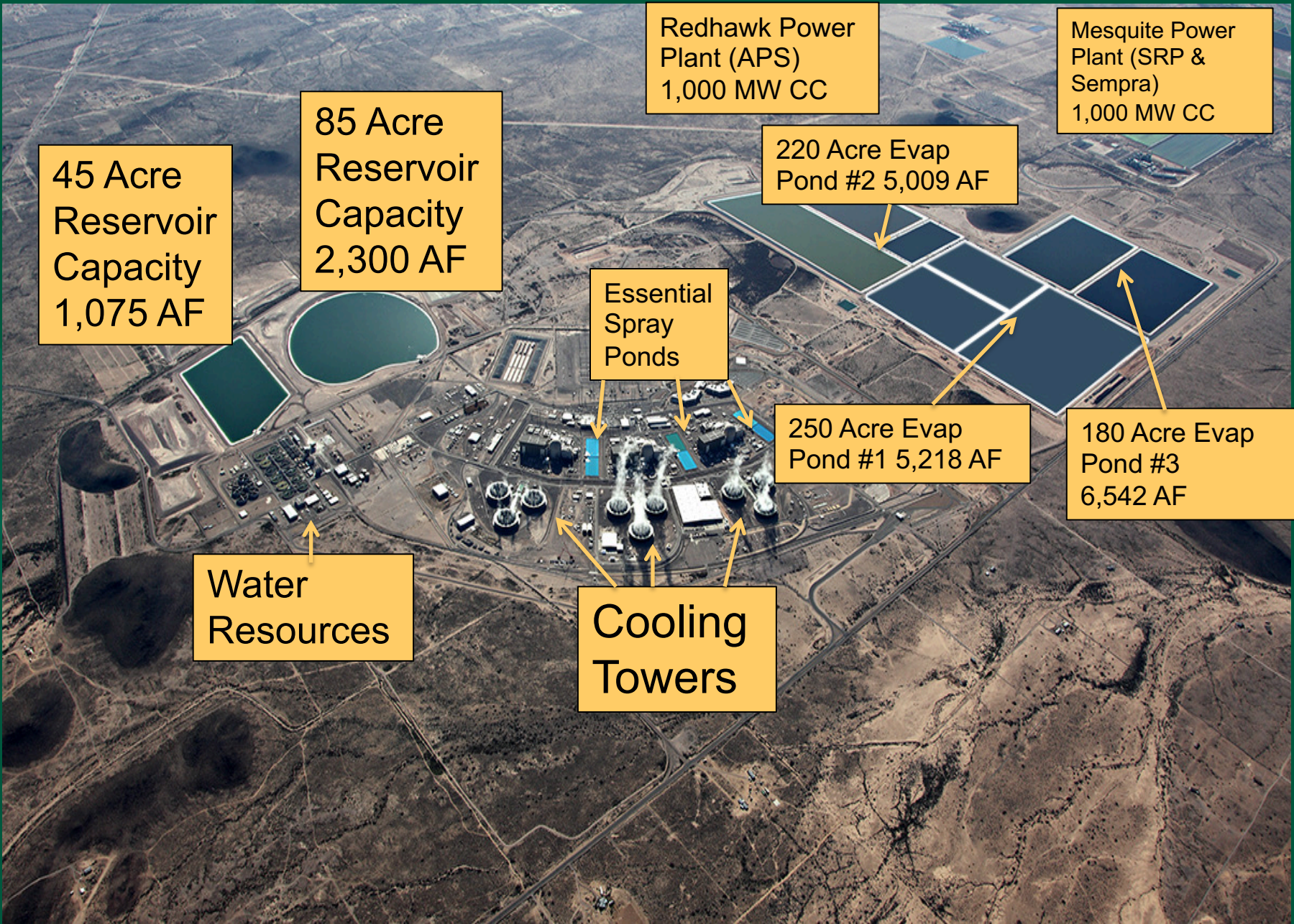


8 miles of  
66" pressure  
flow pipe

Hassayampa Pump Station







45 Acre  
Reservoir  
Capacity  
1,075 AF

85 Acre  
Reservoir  
Capacity  
2,300 AF

Redhawk Power  
Plant (APS)  
1,000 MW CC

Mesquite Power  
Plant (SRP &  
Sempra)  
1,000 MW CC

220 Acre Evap  
Pond #2 5,009 AF

Essential  
Spray  
Ponds

250 Acre Evap  
Pond #1 5,218 AF

180 Acre Evap  
Pond #3  
6,542 AF

Water  
Resources

Cooling  
Towers

# Cooling Water Statistics

2022 Cooling Water Intensity

- 748 gallons/MWh

2022 Cooling Water Use

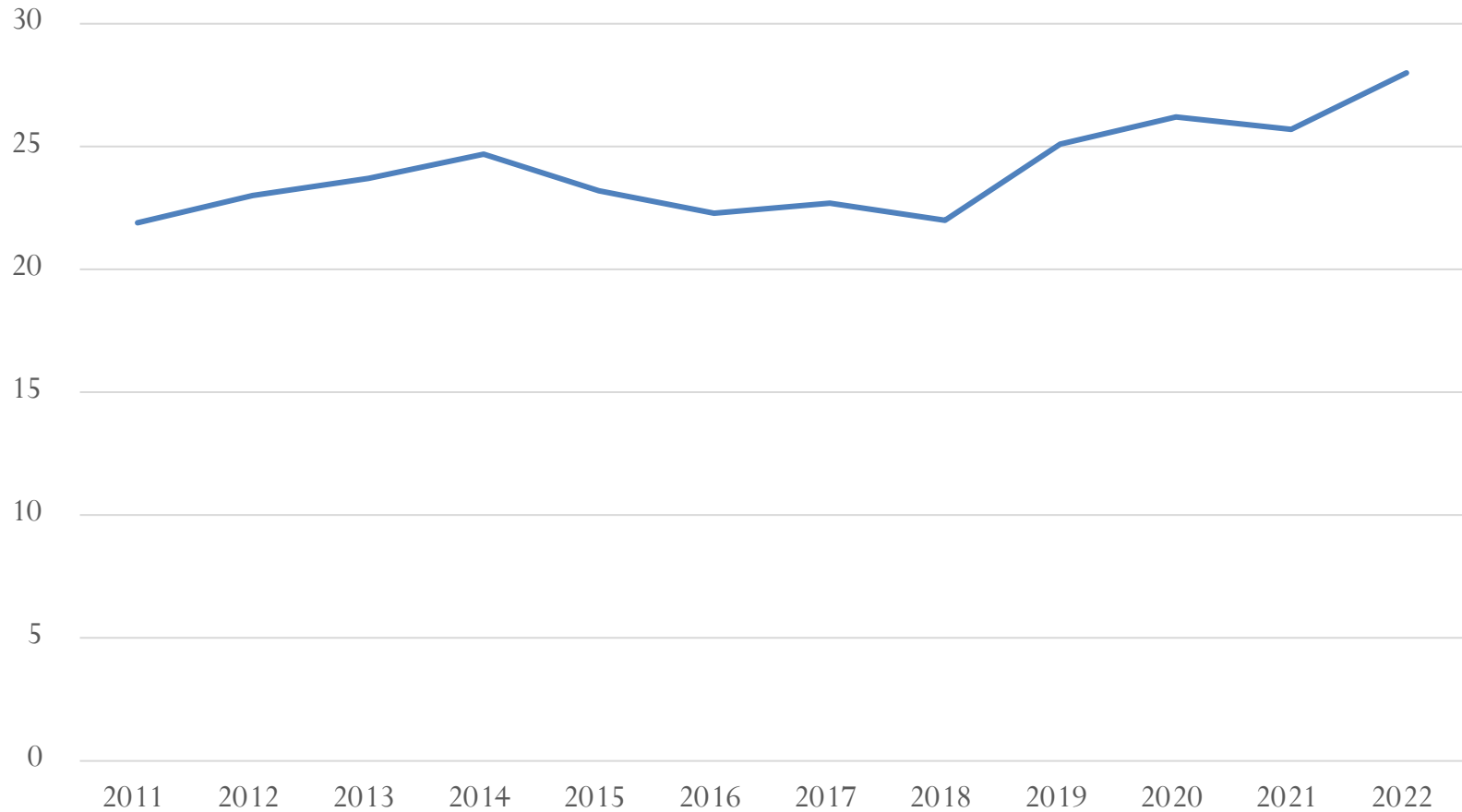
- 73,000 acre-feet

2022 Cooling Water Cycles of Concentration (COC)

- 26.1 average cycles
- 25,000–30,000 PPM TDS
- 7,000–12,000 PPM CI



# Cycles of Concentration



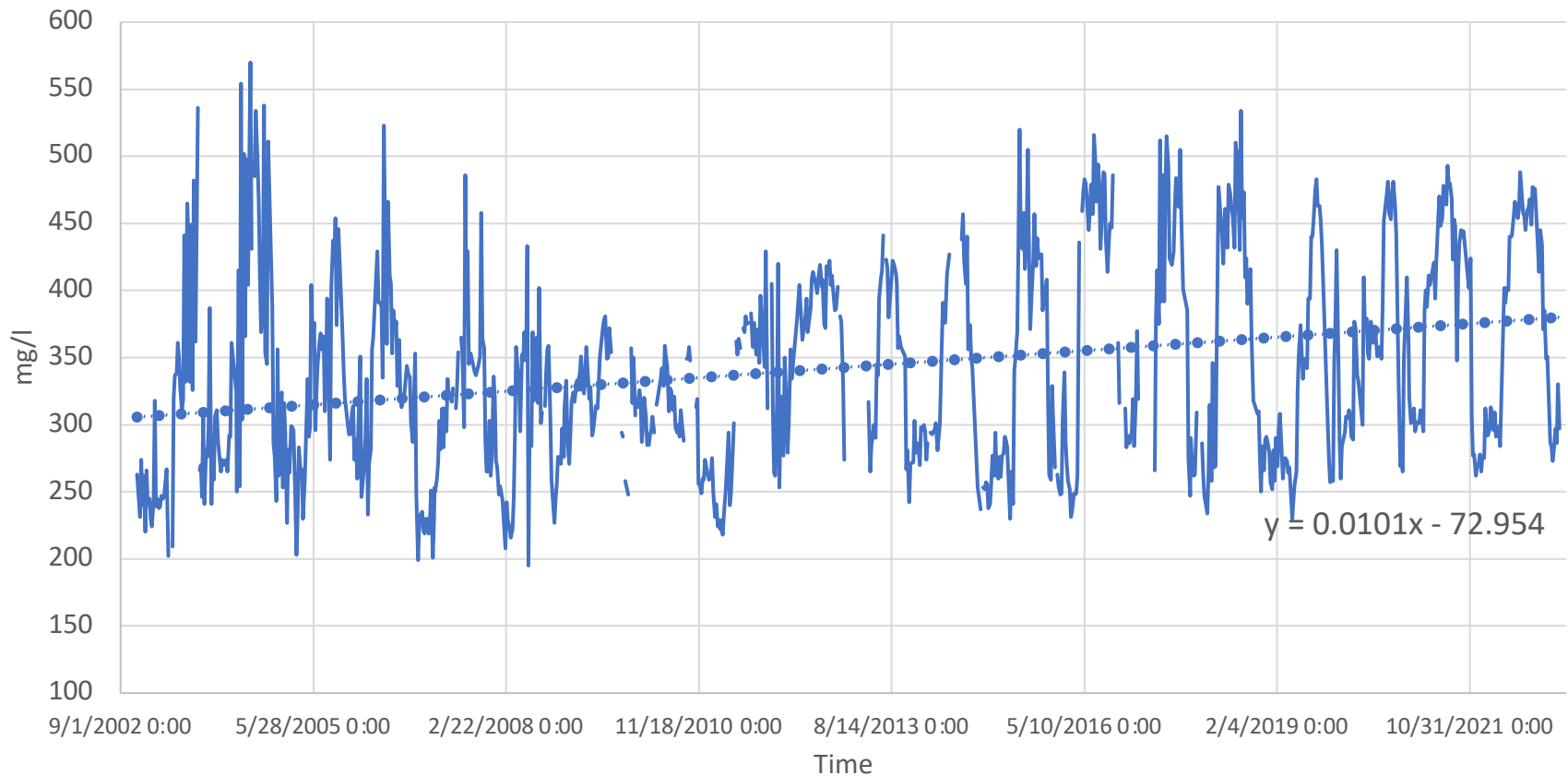
# Water Supply Impacts

- Impacts of extended drought on Palo Verde?
  - Water contract requirements
  - Water contract risks
  - Treated Effluent changes over time and will it degrade further



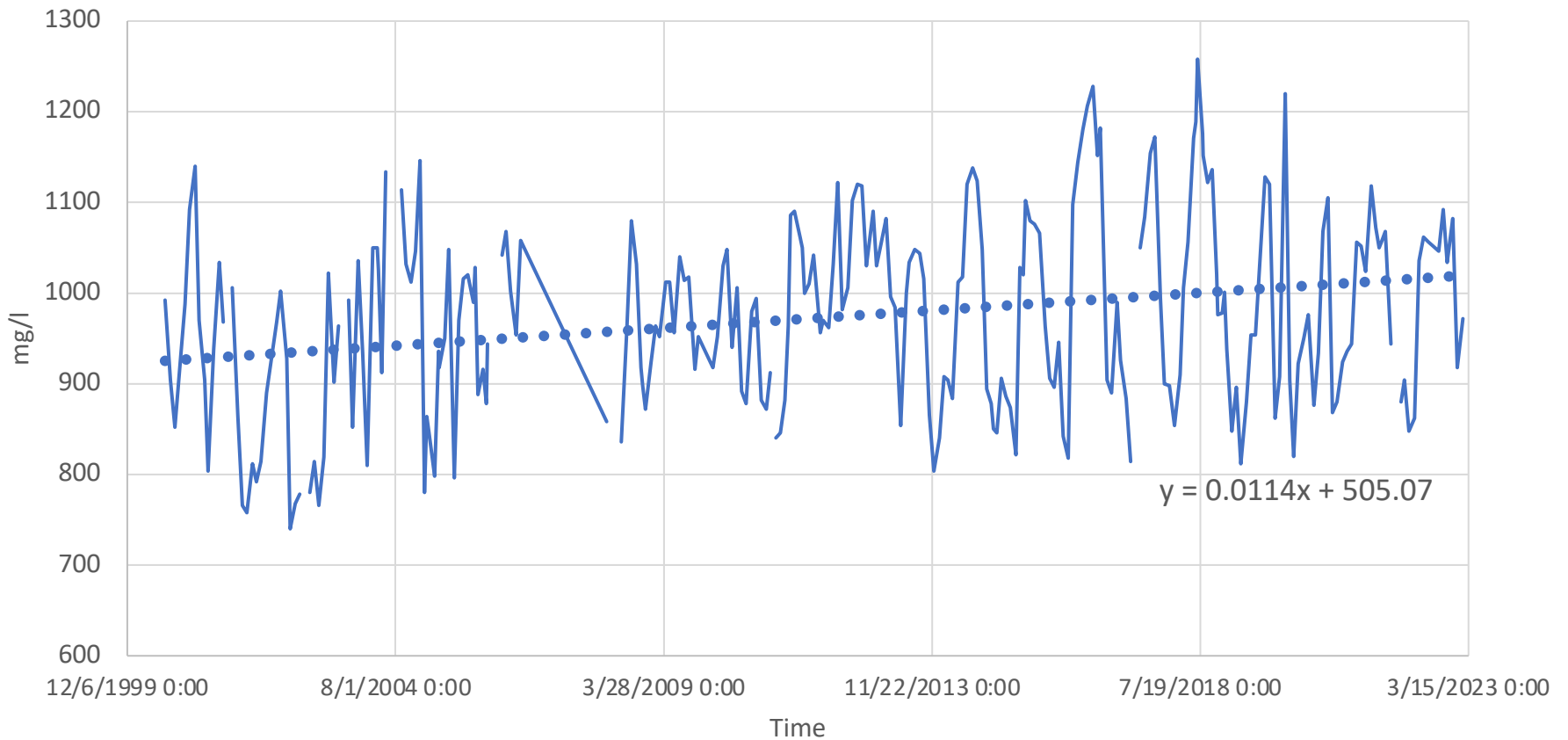
# Water Supply Impacts

## WR Influent - Chlorides



# Water Supply Impacts

## 85 Acre Reservoir TDS



# Water Supply Impacts



# Water Supply Impacts



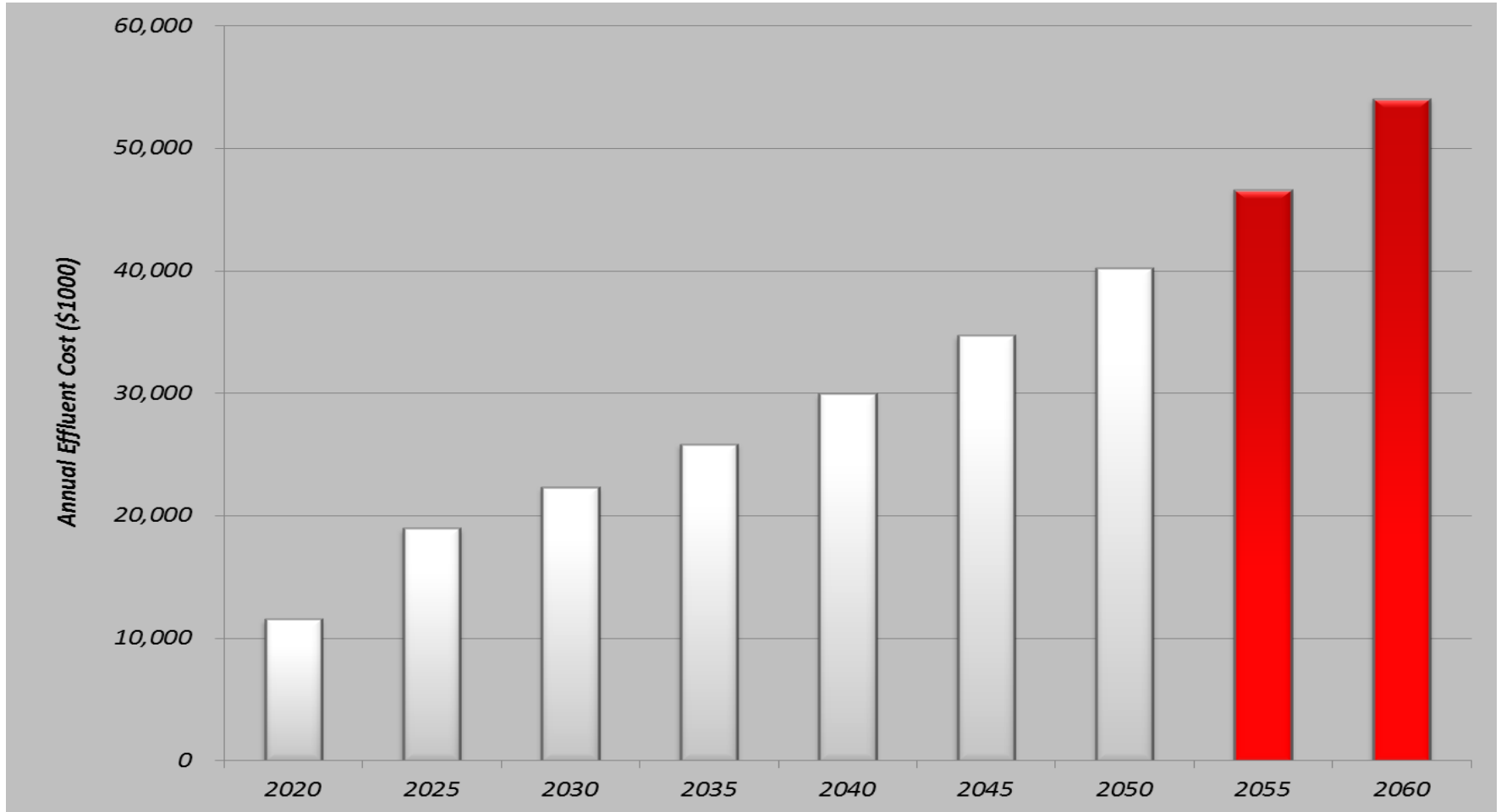


# Water Costs: Arizona vs The World

- Most thermal power plants outside of AZ have very low or no direct water purchase costs
- At Palo Verde, the cost of water has been increasing significantly since 2010 (10.5%/yr)
- In 2026, Palo Verde transitions to a tiered pricing structure
- In addition to the cost of water, chemical costs are also significant and have been drastically affected by the recent market impacts



# Water Costs: Arizona vs The World



# How To Preserve Our Water Resources?

- Reduce how much water is needed
  - Operational Efficiency/Pre-treatment => More CoC
  - Temperatures => Dry cooling to augment cooling towers
- Alternate sources of water
  - PV is the largest reuser of water, what else can we do?
  - Local Brine Management partnerships
- Recycle as much water as possible
  - Treat cooling tower blowdown (~29,000 mg/l TDS) to recover 60%, 80%, 90+% of the water



# Why is Palo Verde (and other Nuclear Units) Important?

## NUCLEAR ENERGY'S EXTRAORDINARY VALUE

### 1. CLEAN

Nuclear energy is a critical part of the U.S. and world carbon-free generation portfolio.



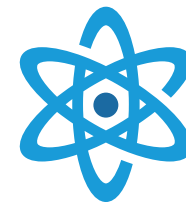
### 2. RELIABLE

Nuclear power plants are the most efficient source of electricity, operating 24/7 at a 92% average capacity factor.



### 3. EFFICIENT

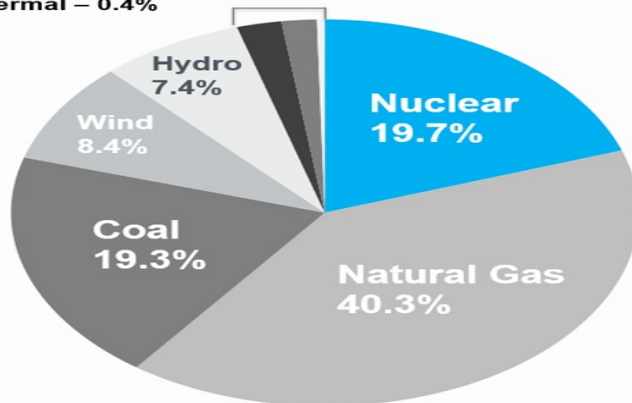
One uranium fuel pellet creates as much energy as one ton of coal or 17,000 cubic feet of natural gas.



# Why is Palo Verde (and other Nuclear Units) Important?

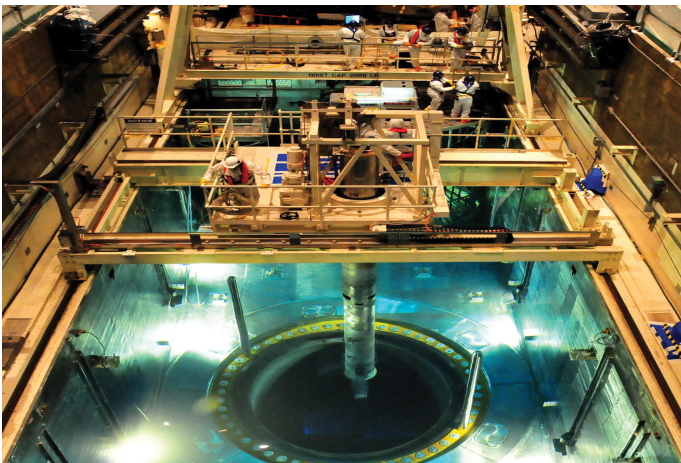
- Palo Verde is currently the largest clean-air energy producer in the U.S.
  - 3 units each producing ~1400 MWe
  - After Vogtle 3&4 come on-line in Georgia they will earn that title
  - A lifetime of waste contained on an area the size of a football field

Solar – 2.3%  
Biomass & Petroleum – 1.8%  
Geothermal – 0.4%



# Why is Palo Verde (and other Nuclear Units) Important?

- Palo Verde provides ~50% of the carbon-free electricity used in Arizona
  - Palo Verde has 7 owners, with ~50% of our electricity staying in AZ
    - 3 California Owners – ~27%
    - 1 New Mexico Owner – ~7%
    - 1 Texas Owner – ~16% (Scott any guesses??)



**A URANIUM PELLETT THE SIZE OF A GUMMY BEAR...**



**1 TON OF COAL**

— OR —

**17K CUBIC FEET OF NATURAL GAS**

— OR —

**3 BARRELS OF OIL**

 **PaloVerde**  
GENERATING STATION



# Why is Palo Verde (and other Nuclear Units) Important?

## PALO VERDE



Workforce development  
& Education

\* Full time APS plus on-site long-term  
contractors

**Source:** Economic Impacts of Palo Verde  
Applied Economics, 2022



# So Where Does Electricity In The SW Go From Here?

- One technology or multiple technologies?
- Will we sacrifice reliability or cost?
- Are any technologies completely environmentally friendly?





# And How Does It Affect Our Water Supplies?

- What technology changes will occur in the next 5, 10 or 20 years?
- And are we willing to change our opinions over time?
- Will I blindly follow my favorite news channels talking points or will I research and become educated?



**QUESTIONS??**

