# Opportunities at the Nexus of Energy and Water

Tribal Renewable Energy Workshop
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National Renewable Energy Laboratory (NREL)
Golden Colorado

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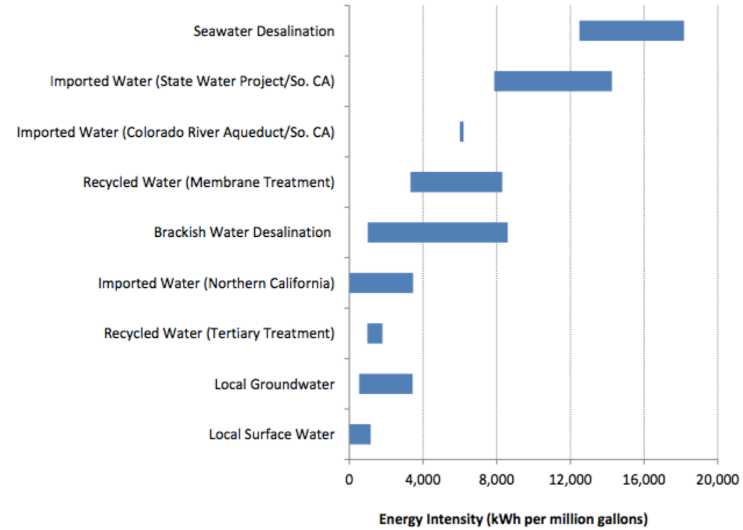
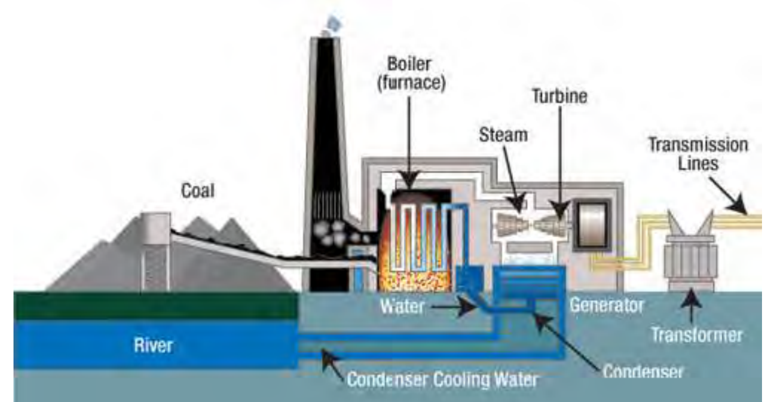
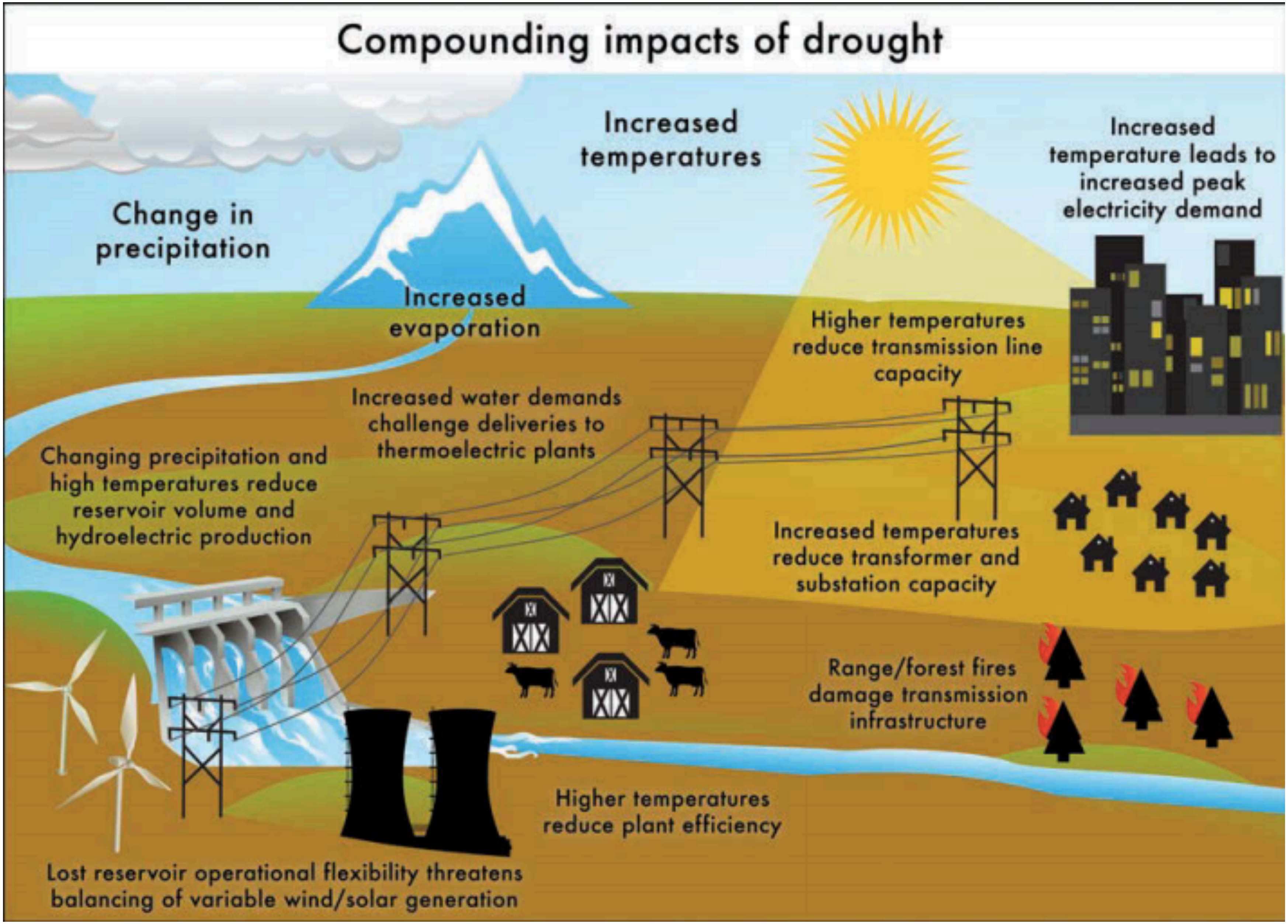
# Water and Energy Interconnected

Central Arizona Project (CAP)



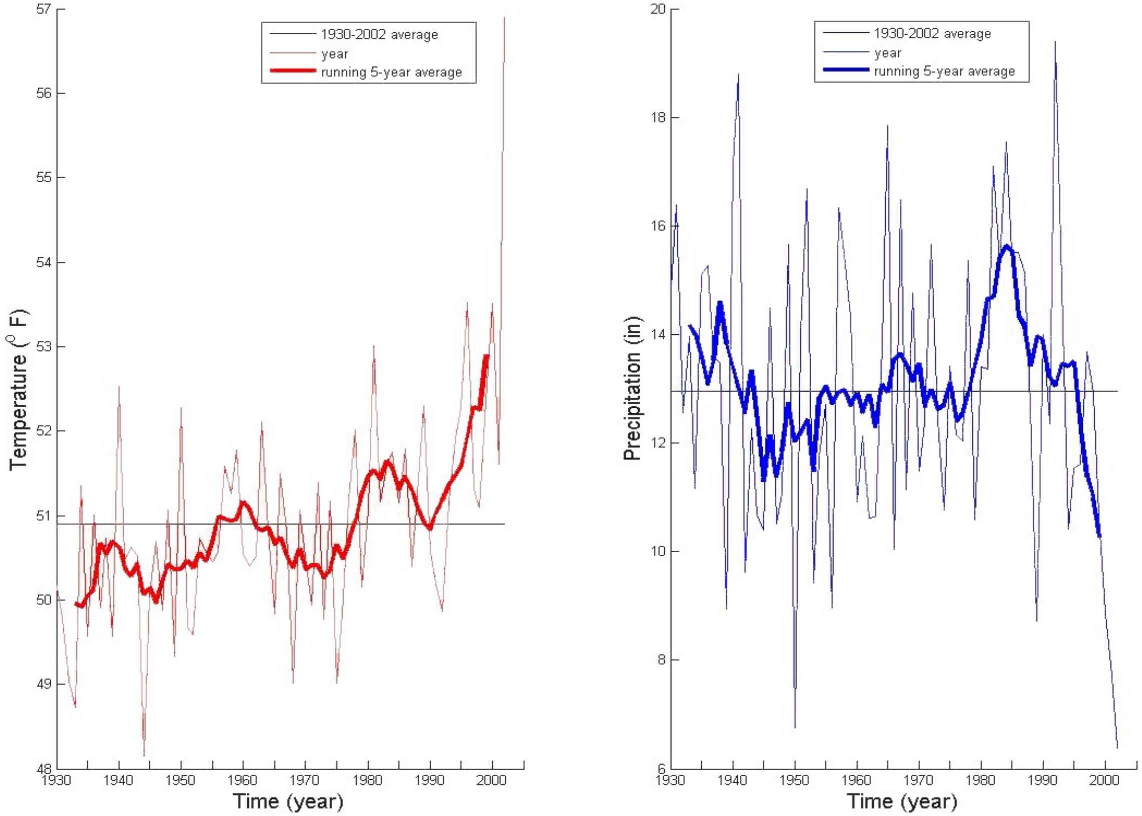




41% freshwater withdrawals in the U.S.

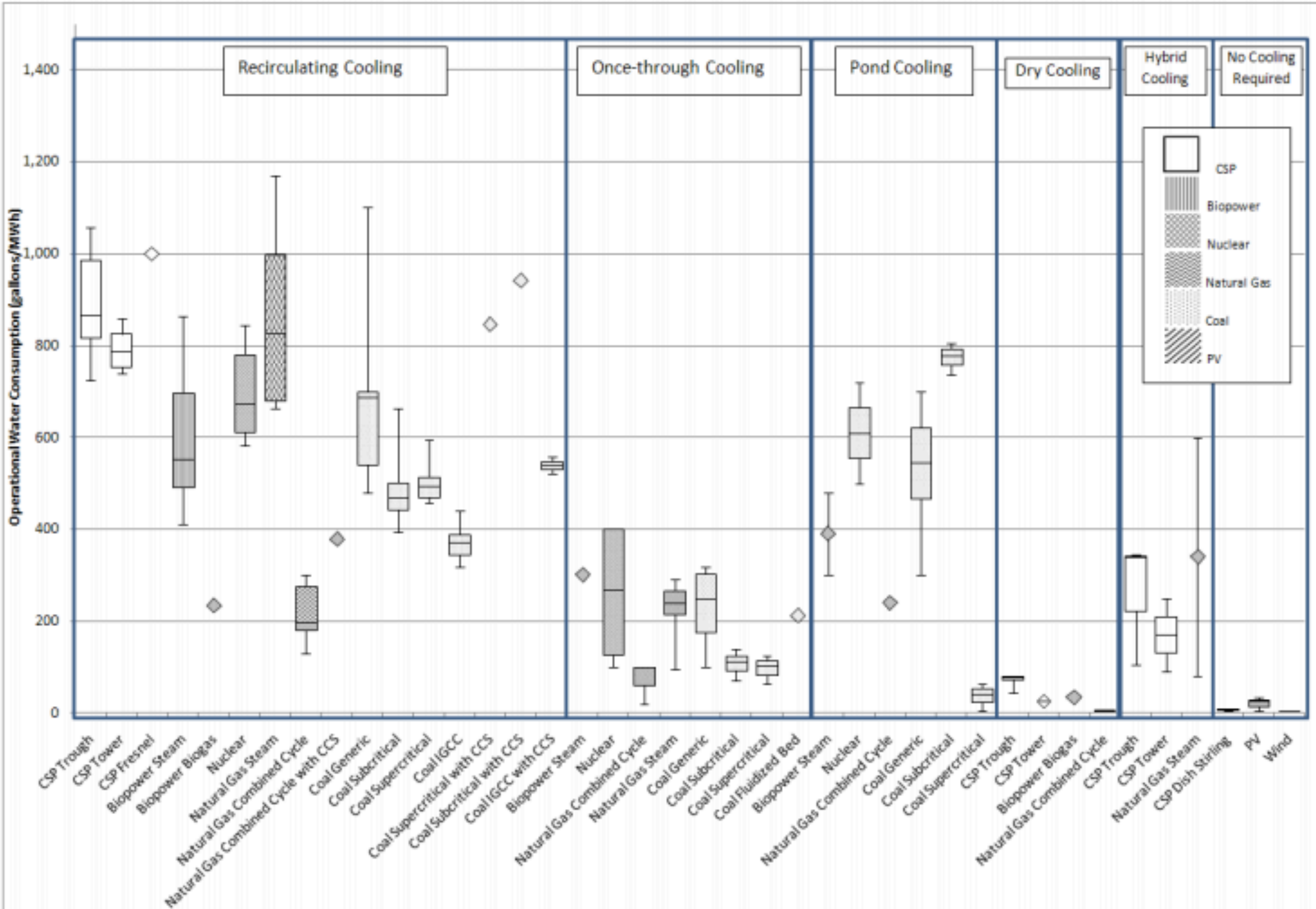



Source: Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy, eds. 2013. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

# Average Temperature and Total Precipitation in the Eastern Plateau Planning Area from 1930-2002.

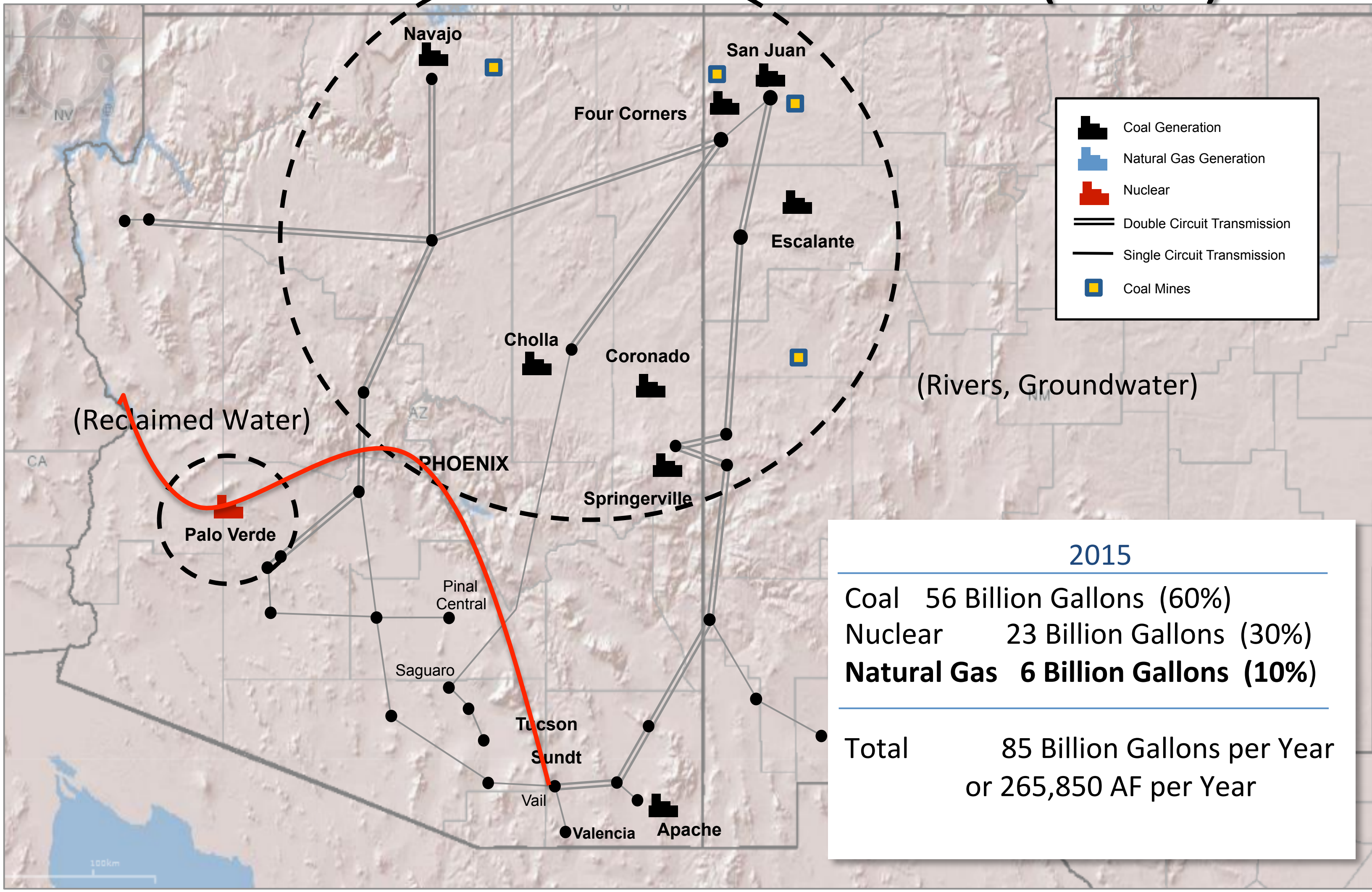



*Horizontal lines are average temperature (50.8 °F) and precipitation (13.0 inches), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values. Data are from selected Western Regional Climate Center cooperative weather observation stations located south of the Little Colorado River. (http://www.wrcc.dri.edu/summary/climsmaz.html). Figure author: CLIMAS*




*Source: A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies. Technical Report NREL/TP-6A20-50900.* March 2011.

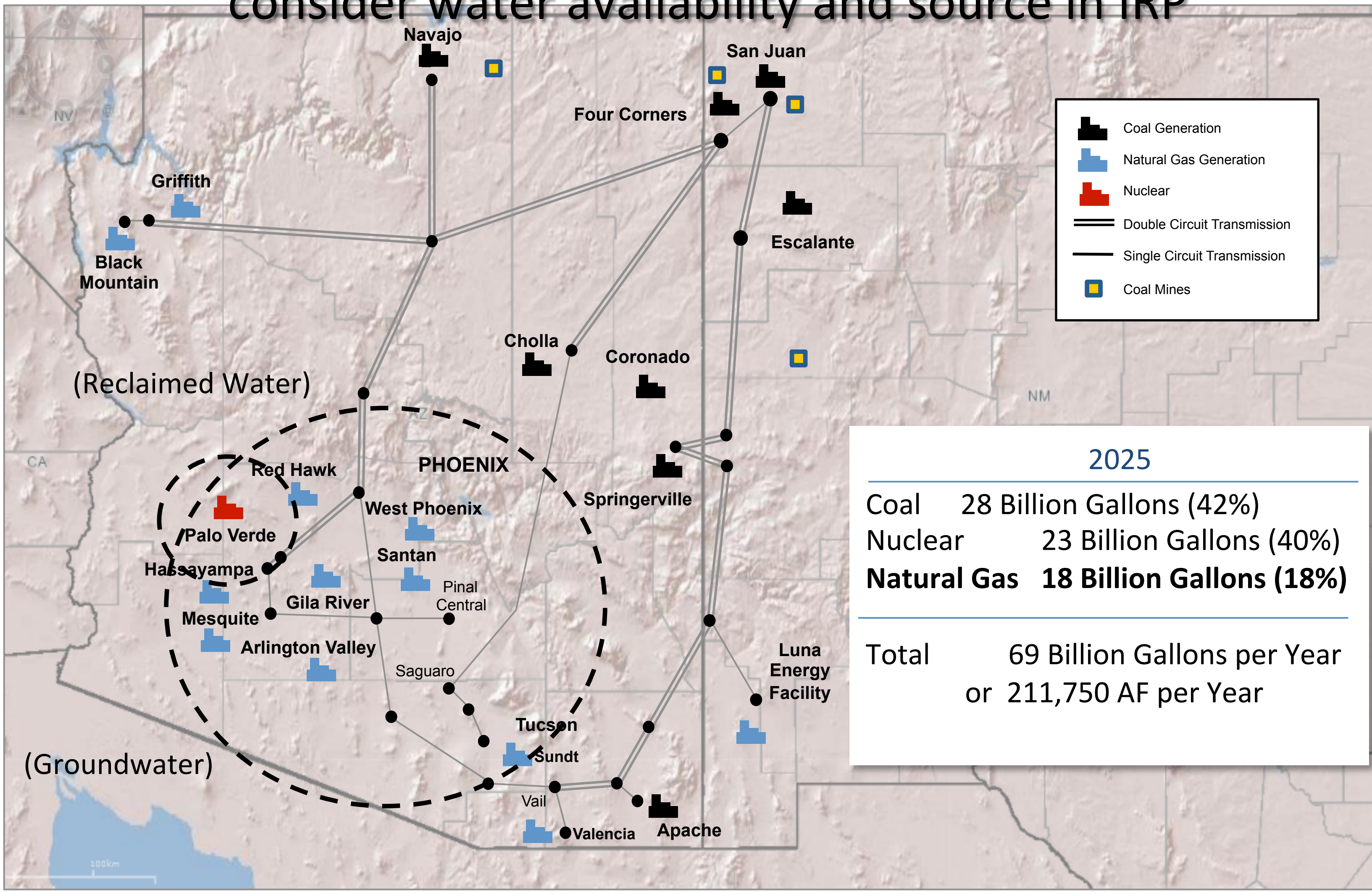
# Power Generation Water Use (2015)




*2015 results based AuroraXMP dispatch simulations for the Desert Southwest region. Source: Tucson Electric Power, 2015. UA/NSF water, energy, food nexus workshop, April 2015, Biosphere 2.*

# Power Generation Water Use (2025)

## consider water availability and source in IRP




*2025 results based on AuroraXMP dispatch simulations for the Desert Southwest region assuming potential environmental regulations under Regional Haze and the Clean Power Plan 111(d). Net load forecast assumes current standards for distributed generation and energy efficiency in AZ and NM. Source: Tucson Electric Power, 2015. UA/NSF water, energy, food nexus workshop, April 2015, Biosphere 2.*

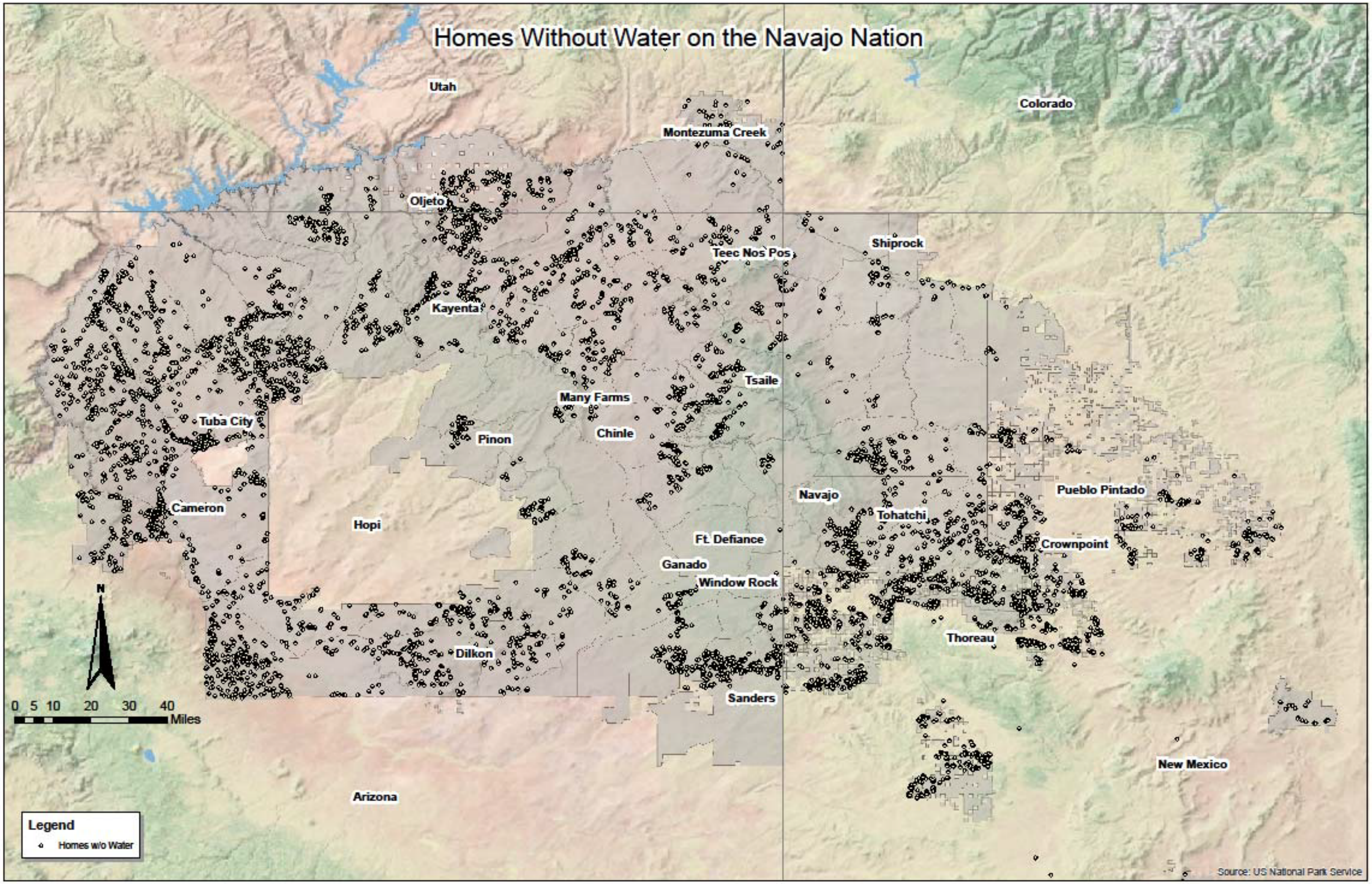



Figure 1. Distribution of homes without access to a proximate water supply in the Navajo Nation (Navajo DWR, 2011; provided by Mr. Ronson Chee). There are > 8000 such homes in the Nation, where the cost of obtaining potable water can be as high as $43,000/AF.

# Navajo Solar Desalination Demonstration Pilot Project

- Diminishing water supply , impaired brackish water supply, need to incorporate renewable energy
  - 35% - 40% population off-grid in Southwestern area
  - $10 - $35/1000 gallons
  - 1500 – 15000 TDS
  - Well depth 400 to 1,600 feet
  - Hauling water averages 40 miles round-trip
  - Residential gas generators used for temporary power
  - residents use less water, pay a higher unit price for water/energy and use a greater percentage of their income for power and water than virtually any other group in the United States

- Can a new water supply be developed incorporating an economically and culturally appropriate desalination technology that utilizes renewable energy to service areas lacking basic infrastructure for water and electricity?

- Partnership between the Bureau of Reclamation, University of Arizona, and Navajo Department of Water Resources

- **Scalable and transferable.** Appropriateness for distributed generation, scale to meet different needs.
- **Cost efficiency/affordability.**

2 systems at a minimum combined 5,500 gallons per day of potable quality water at a cost within the resident's willingness to pay.

The average per capita consumption of water is 40 gal/day .

- **Independent operation**. The system works off-grid using only renewable energy. Control system and battery storage
- **Materials availability**. All parts available off the shelf from common commercial sources.
- **Serviceability.** The equipment is easy to maintain and operate.
- **Remote monitoring and operational control.**

# Leupp Arizona Pilot Project Research Site

Cogeneration Solar of thermal/electricity generation and membrane distillation

Photovoltaics and Nanofilration

# Broad Array of Benefits

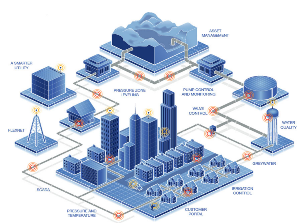
identified through community triple bottom line analysis

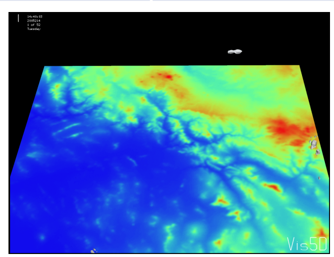
- Capital costs, O&M costs, one-time project costs
- Economic, social and environmental benefits
  - Avoided and deferred water supply costs
  - Reduced travel time to haul water
  - Increased Reliability – enhancing local water availability
  - Resiliency to increased drought conditions
  - Enhance rangeland management
  - Local production improves water quality
  - Preference for solar energy in water treatment and pumping
  - Preserve and sustain a life way
  - Contribute to workforce development

- Partnership with tribal water and energy institutions, programs and community
- Develop options for new technology and solutions to treat water utilizing renewable energy
- Co-produce methods and toolsets of assessment
  - Baseline assessment of water energy demand
  - Economic, social and environmental impacts
  - Site assessment and community engagement
  - Permitting, regulations, rate design
- Brine management
  - Halophyte production
  - Mineral recovery
- Microgrid desalination
  - Deferrable load
- Education and training

## Applied Research & Education Site (ARES)

| # Arizona is the Living Laboratory | Situational scarcity: Energy, water, food, strategic materials can and will be scarce in localized regions & time periods<br>**Solutions in development:** |
|---|---|
| • New waste-to-energy technologies<br>• Decentralized and distributed energy/water treatment technologies<br>• Generation projects utilizing low water technologies<br>Renewables (PV solar and wind)<br>Increased use of reclaimed water | • Integrated water and energy policy and decisions-making<br>• Socioeconomic value of potential statewide energy saving strategies across the water-use life cycle<br>• Socioeconomic return of investment in more energy-efficient water and wastewater systems |
| New materials platforms & systems level technologies flexibly targeted to:<br>• energy-efficient water reuse and purification<br>• multi-analyte sensor platforms | • Smart water-energy data platform<br>• Low energy, low carbon, low cost desalination with brine disposal and recovery |
| Improved renewable integration on the power grid<br>• Smart grid and storage technologies<br>• Optimization of hydro and pumped storage facilities<br>Co-Production of food and fuel and sequestration of CO2– Algal based Biofuels | • Energy production and use of water availability and security in groundwater and surface water source<br>• Hydroclimatic modeling and power forecasting for energy production |



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