This presentation premiered at WaterSmart Innovations

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SRP: A Water/Power Nexus for Over 100 Years

Analysis of the Embedded Electricity in Water for a Single-Family Home in the City of Phoenix

Presentation to Water Smart Innovations 2010 Conference
Karen Collins
October 6, 2010

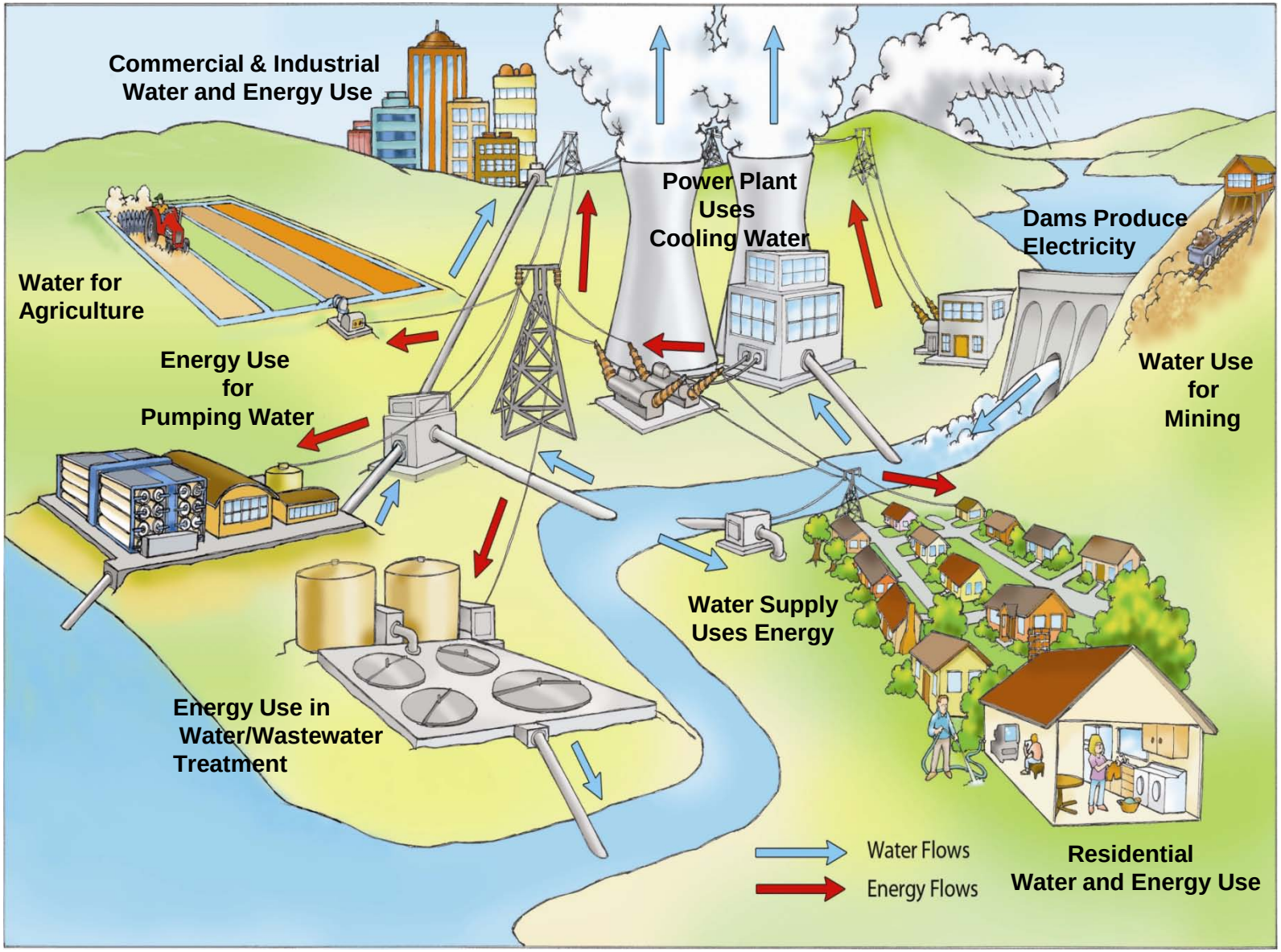
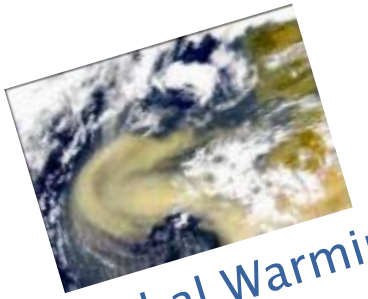
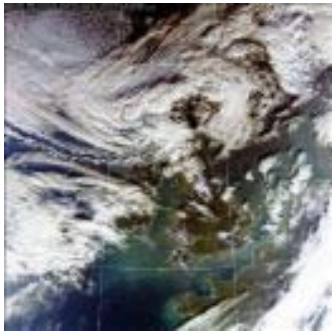


Image from "Energy Demands on Water Resources," US Department of Energy, 2006

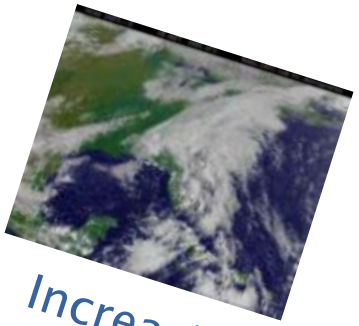
Calamity, Mitigation, or Adaptation?



Global Warming

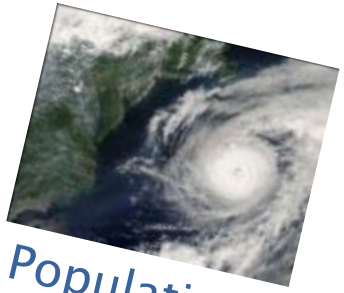


Drought



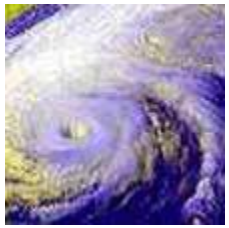
Increasing Energy Demand

Environmental Issues



Population Growth

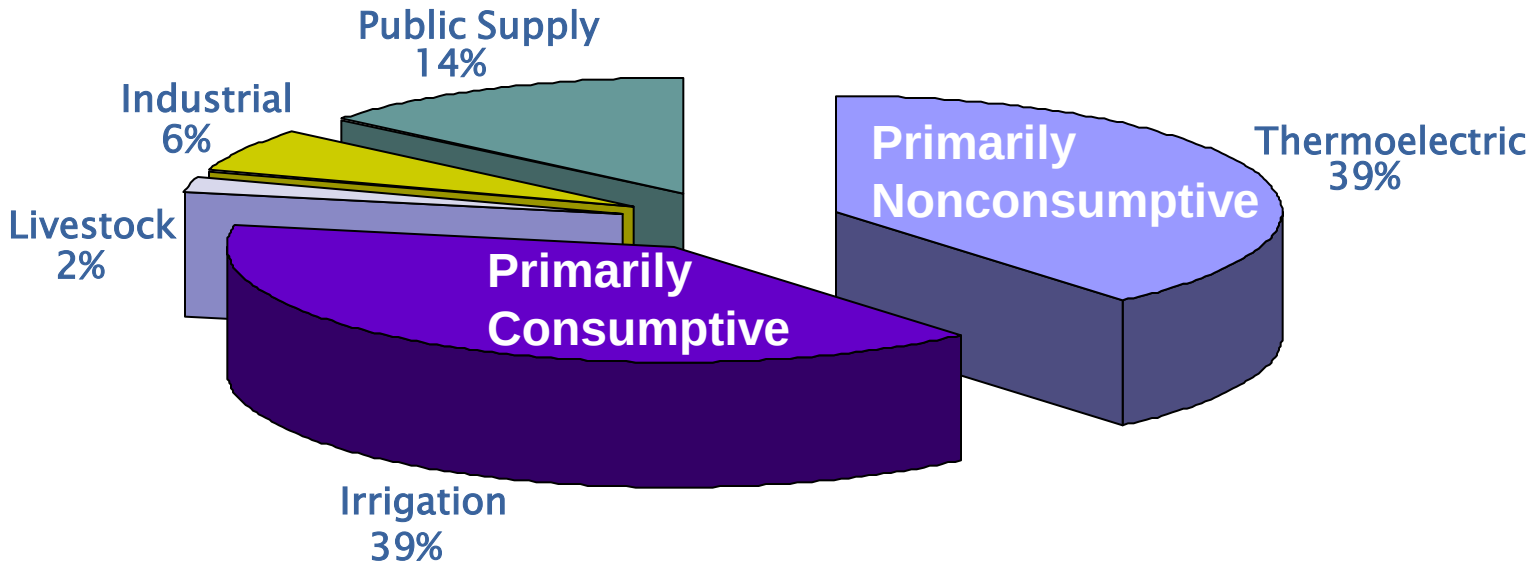
Limited Funds



BANANA

Nationally, Electricity Generation and Agriculture Sectors Rely on Fresh Water

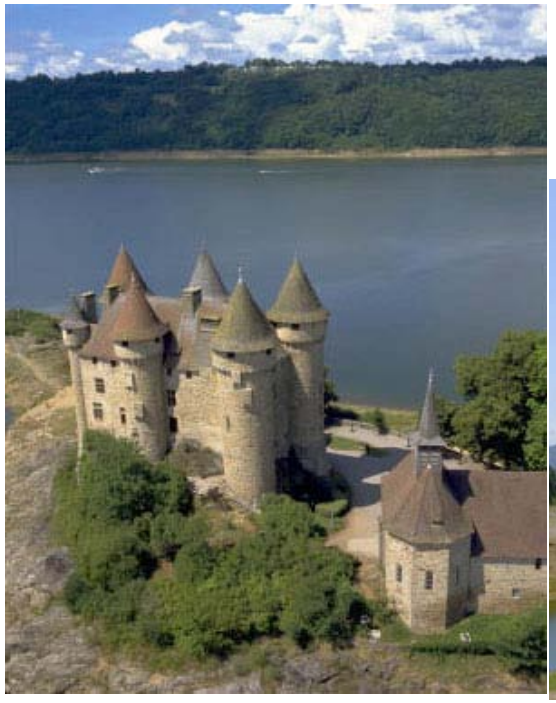
Estimated Freshwater **Withdrawals** by Sector, 2000



Source: USGS Circular 1268, March 2004

2003 Heat Wave Impact on French Electric Power Generation

- Loss of 7 to 15% of nuclear generation capacity for 5 weeks
- Loss of 20% of hydro generation capacity
- Large-scale load shedding
- Sharp increase of spot-market prices



Normal conditions in August

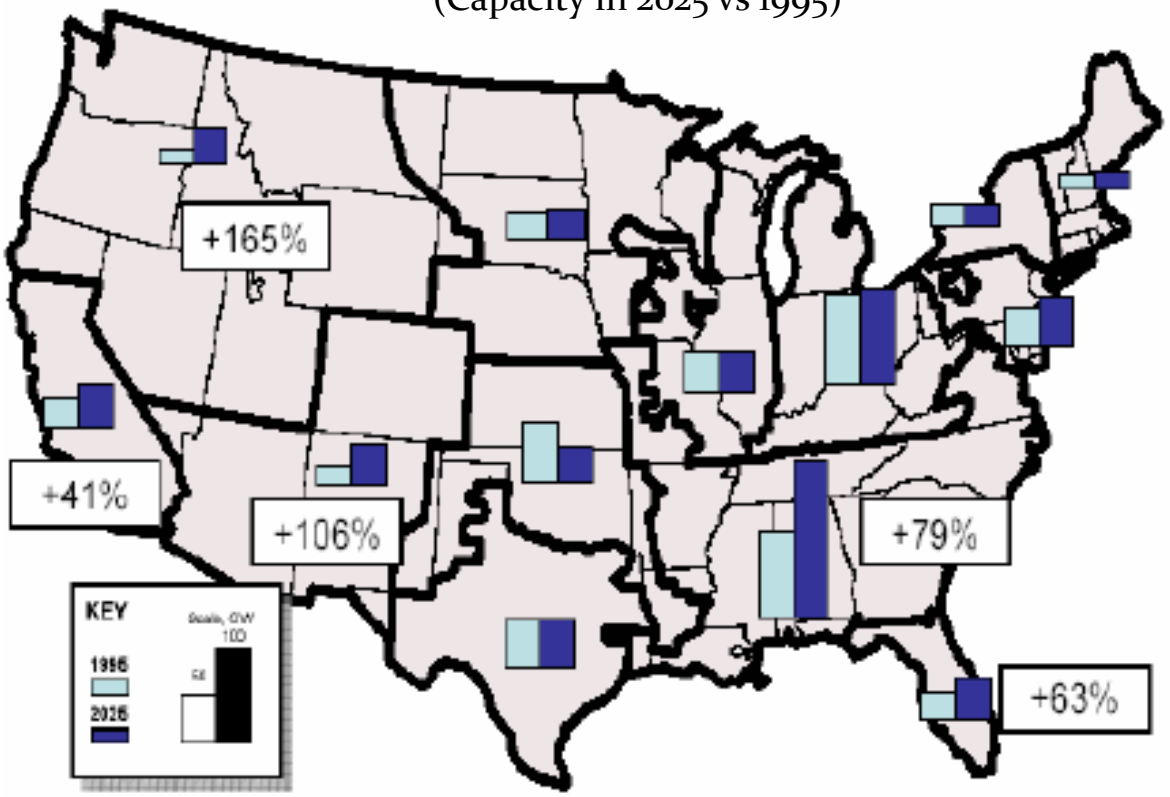
Bort-les-Orgues Réservoir

August 27, 2003

Growth in Thermoelectric Power Generation

- Most growth in water stressed regions
- Most new plants expected to use evaporative cooling

Projected Thermoelectric Increases
(Capacity in 2025 vs 1995)



Source: NETL, 2004

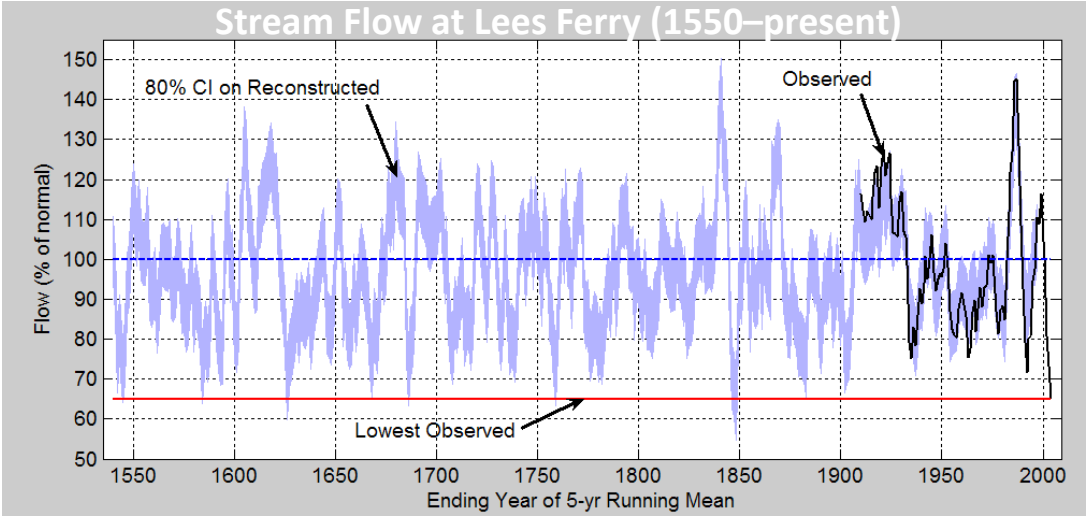
Drought

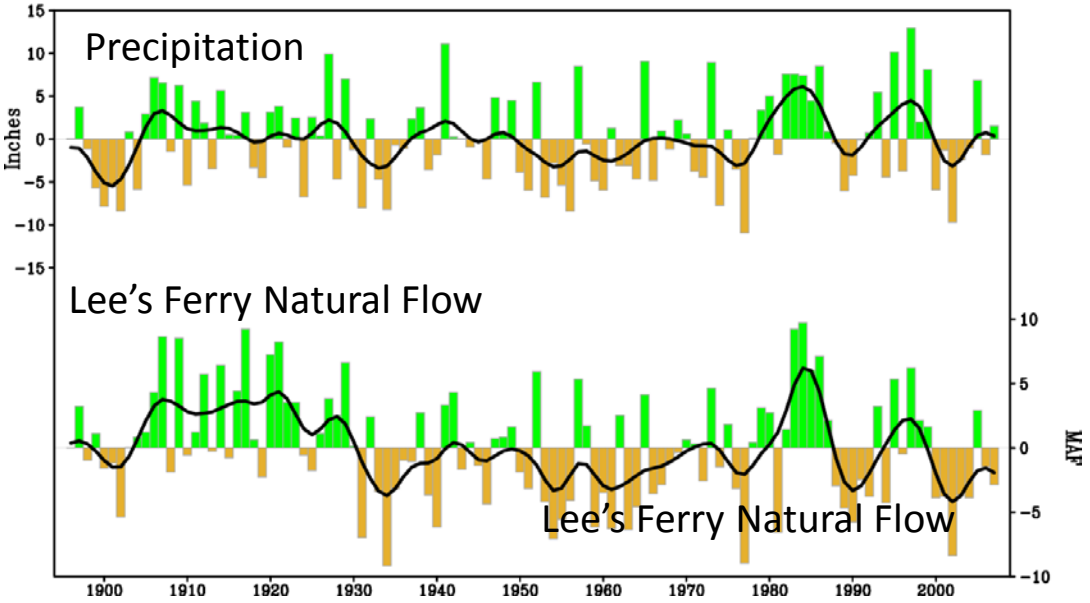
Drought has been less frequent & less severe compared with the last 1000 years

- Historical low flows can be attributed mainly to **changes in precipitation**

- Recent **warming has contributed** to the severity of drought in the southwest United States

Will future droughts be qualitatively different because of projected warming?





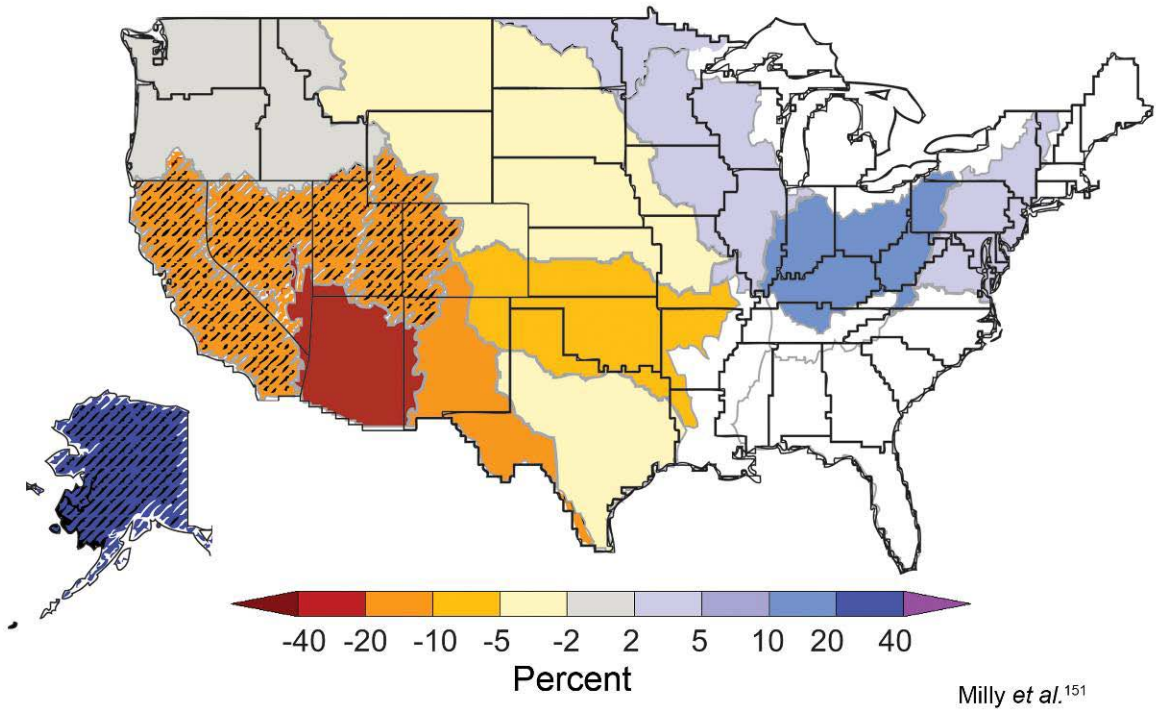
Source: CO Climate Report, 2008

Regional Focus: Southwest & Colorado River Basin

- Provides water for 25 million people, 38 million by 2020
- Serves Phoenix, Denver, LA, Santa Fe, SLC, Albuquerque
- Major Transmountain diversions
- Supports $1.2 trillion economy
- 15% of area provides 85% of water

Regional Water Resources

% change in runoff (2041–2060)

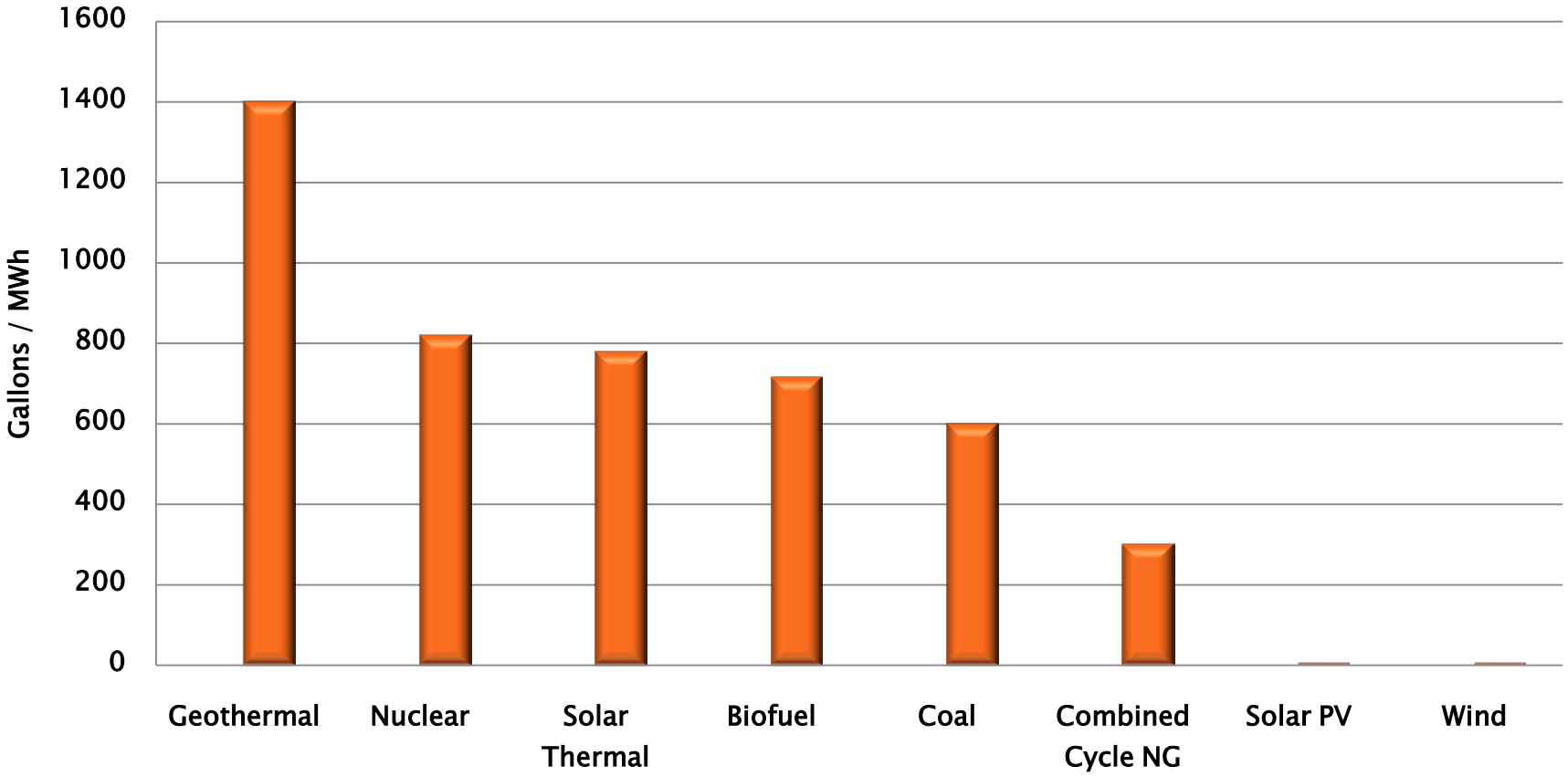


Milly *et al.*[151]

- 90% of models agree at least a 10% decline in annual runoff across the Upper CRB to California by 2050
- Increases the risk to Colorado's water supply *even if precipitation remains at historical levels*

"...requirements of the CO River Compact may only be met 60–75% of the time by 2025...." (IPCC Technical Report on Water, 2008)

Trade-offs Between Energy and Water in Future Generation Choices



Source: Sandia National Laboratories, CEC PIER (CA), EPRI

California Researched the Nexus

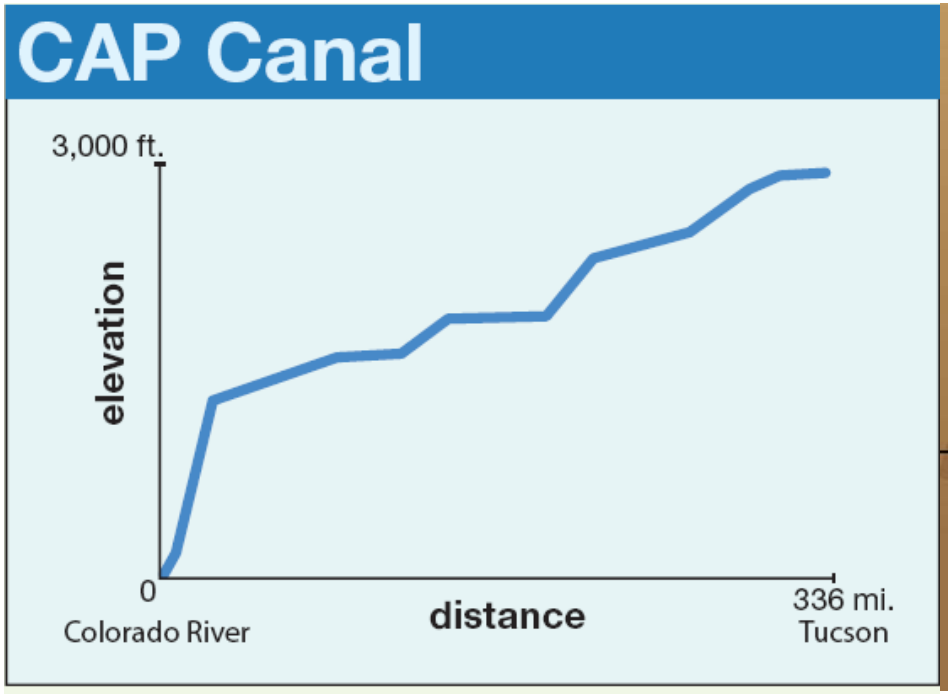
"…***water-related energy use consumes 19% of the state's electricity***, 30% of its natural gas, and 88 billion gallons of diesel fuel every year…"

California Energy Commission
California's Water-Energy Relationship - Nov 2005

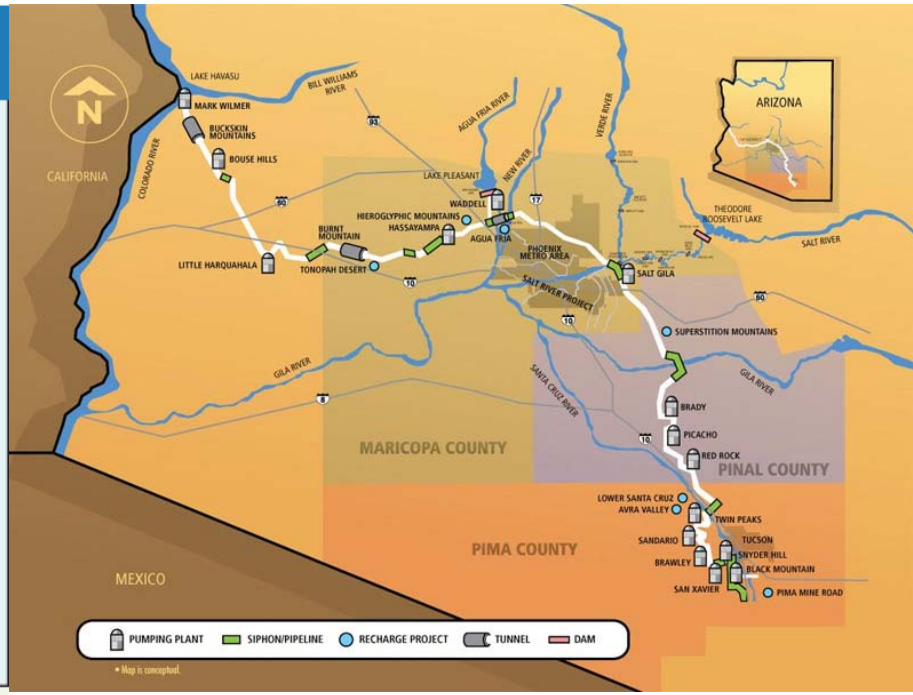
"95% of the energy efficiency goals could be met in water efficiency programs at 50% of the cost"

Mary Ann Dickinson
CA Urban Water Conservation Council

Central Arizona Project
Largest Arizona Power User



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



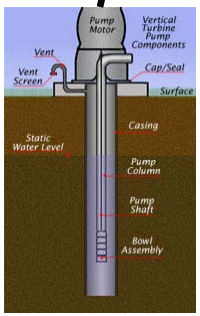
CAP consumes nearly 3 million MWHs annually

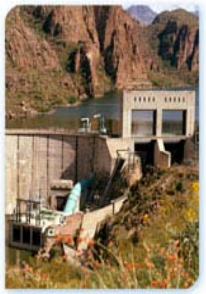
Phoenix Residential Water Use Cycle

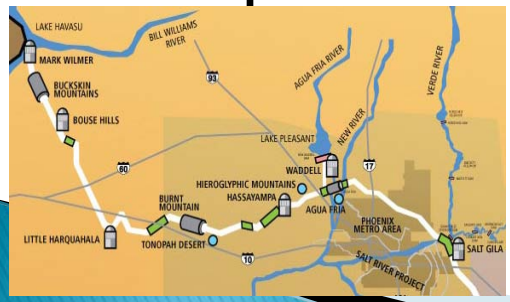
A. Water Supply (pumping / conveyance)

B. Water Treatment (WTPs)

C. Water Distribution (booster pumps, etc.)







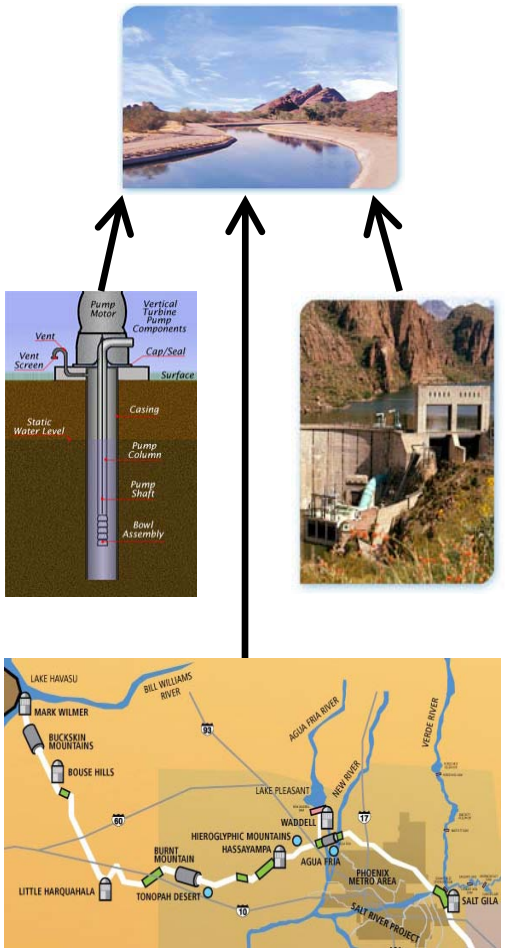
Effluent Discharge / Reuse

D. End Use (home)

E. Wastewater Collection (lift stations, etc.)

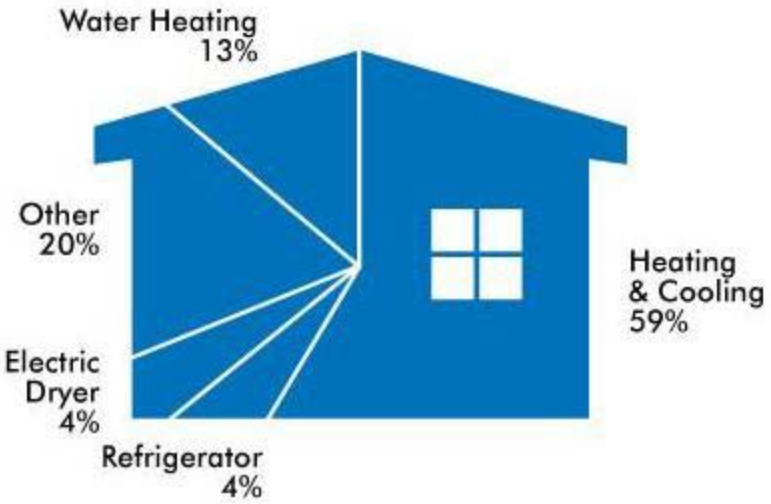
F. Wastewater Treatment (WWTPs)

A. Water Supply Assumptions



- COP water supply:
  - Residential ~ 66% of total
  - Single-family homes ~77% of residential
- "Normal" year supply mix:
  - 97% surface water
    - ✓ 54% SRP, 46% CAP
  - 3% groundwater (COP wells)
- Groundwater well *extraction*:
  - COP pump factor = 1,156 kWh/AF
  - SRP pump factor = 437 kWh/AF
- Canal system *conveyance*:
  - CAP pump factor = 1,602 kWh/AF

D. End-Use Assumptions



- City of Phoenix home
  - ✓ Single-family detached
  - ✓ 1,500 square feet
  - ✓ Total electric
  - ✓ No pool
  - ✓ Family of 4
- 35% of water is used indoors
- 30% of indoor water is heated
- Water heating is the only water-related energy use

Electricity Use and Carbon Emissions – Annual Home Water Use

Component of Water Use Cycle	Water Use (kgal)	Electricity Use (kWh)	Emissions (lbs CO_2e)
A. Water supply (pumping / conveyance)	141	419	617
B. Water treatment	133	23	34
C. Water distribution	133	161	236
D. Home water use (heated and unheated)	122	2,788	4,099
E-F. Wastewater collection / treatment	43	69	101
Total		3,460	5,087

Summary of Embedded Electricity – System vs. Home Water Use

System

Component	Intensity
Water supply (pumping / conveyance)	3.0 kWh / 1000 gal
Water treatment / distribution	1.4 kWh / 1000 gal
Wastewater collection / treatment	1.6 kWh / 1000 gal
Overall system *	**4.8 kWh / 1000 gal**

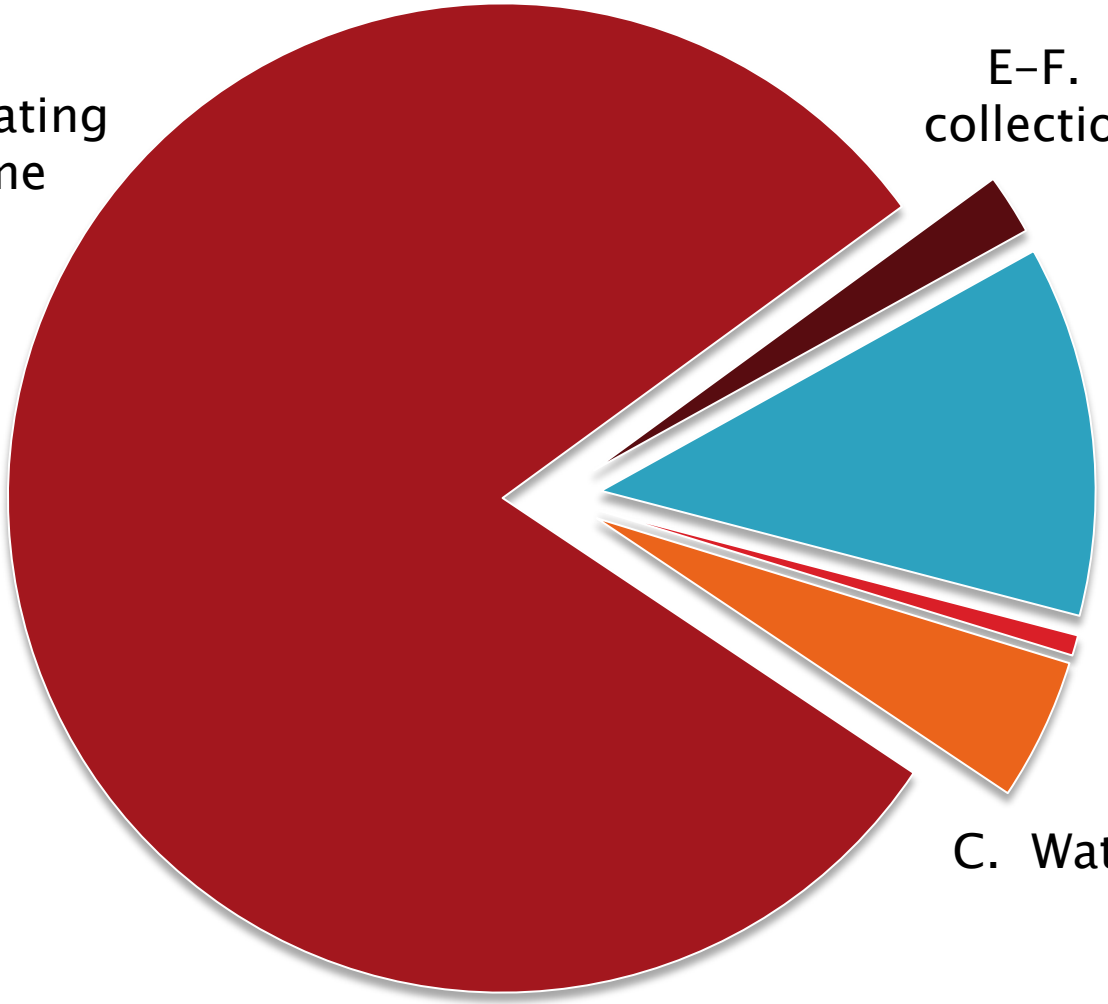
Home

Component	Intensity
Home water use (heated and unheated)	22.8 kWh / 1000 gal
	22.8 kWh / 1000 gal

Overall cycle intensity * = 24.5 kWh / 1000 gal

* "Overall" intensities take into account the relative "weight" of each contributing component.

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.*

What this Means…for a Home

- **Monthly** water use of ~10,000 gallons translates to
  - ✓ About **300 kWh** of embedded electricity
  - ✓ About **430 pounds** of CO_2e

*300 kWh is the equivalent of leaving four (4) 100-watt light bulbs burning non-stop **all month long**!*

What This Means…for a Community

If all 410,000 Single Family homes in the City of Phoenix were like the households we modeled:

- ✓ Nearly **1.5 million MWh** of embedded electricity
- ✓ Nearly **950,000 metric tons** of CO_2e

*This is roughly the equivalent of annual GHG emissions from **175,000** passenger vehicles.*

Impacts of Water Conservation

The savings compound if a community works together to conserve.

- 10% reduction in water use (~12,000 gallons/yr) saves:

  ✓150,000 MWh of embedded electricity

This is enough energy to power nearly 7,000 homes for a year – through water conservation alone!

95,000 metric tons of CO_2e avoided

Saving water saves energy, which results in additional water savings at the power plant…this could amount to nearly 80 million gallons saved at the power plant each year.

Paradigm Shift

This is a
water-saving device!

This is an
energy-saving device!