

Estimating Energy and Greenhouse Gas Emissions Embedded in Metered Water at the University of Arizona

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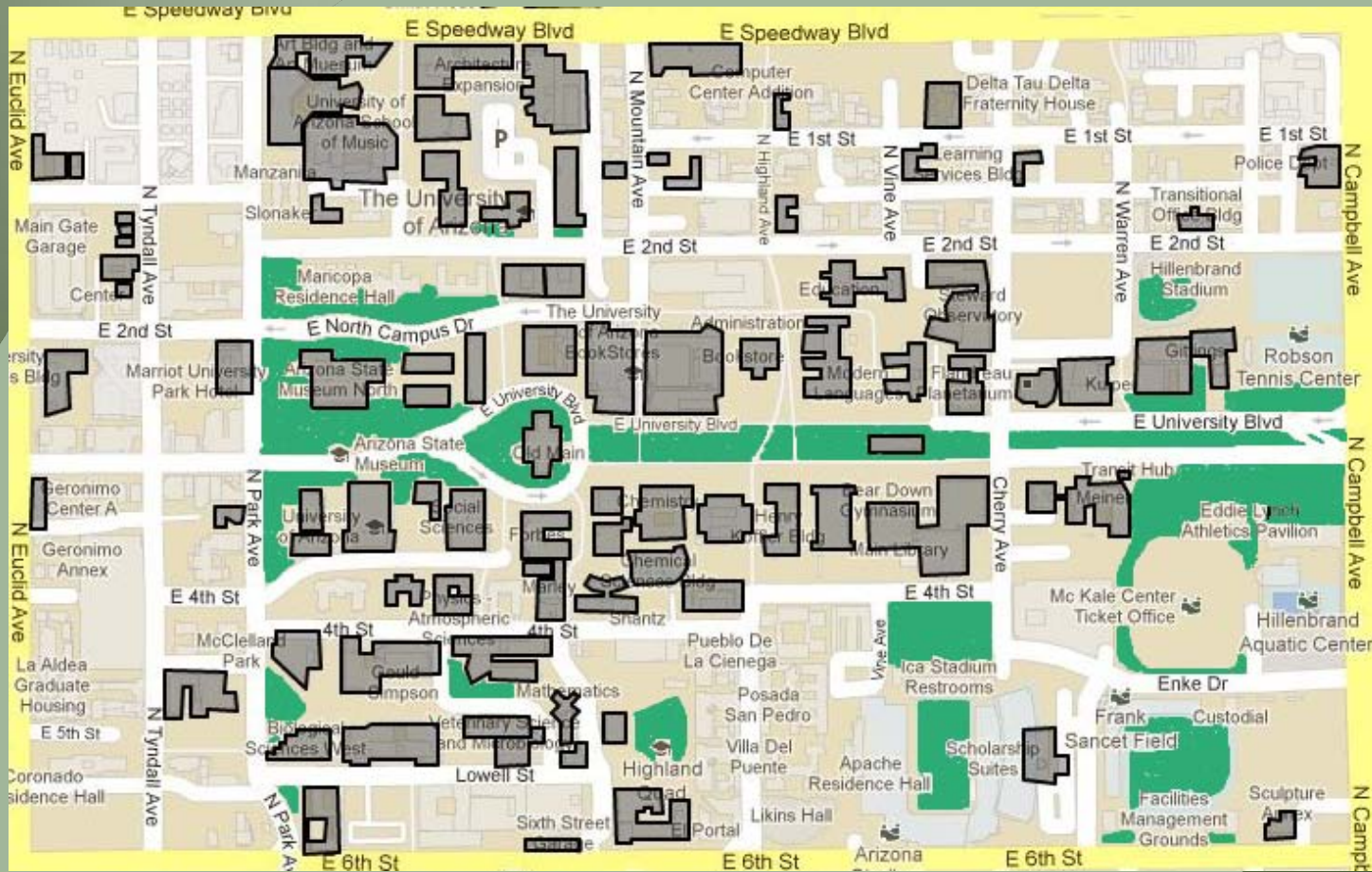
Joe Abraham, PhD

Director
UA Office of Sustainability

Greenhouse Gas Accounting 101

- Leading questions:
 - Where are the emissions coming from?
 - Is water conservation an effective GHG mitigation strategy?
- Apportioning GHG emissions to water sources
 - Where is the water is coming from?
 - What energy is consumed? What fuels are used?

UA Green Spaces



UA Mall

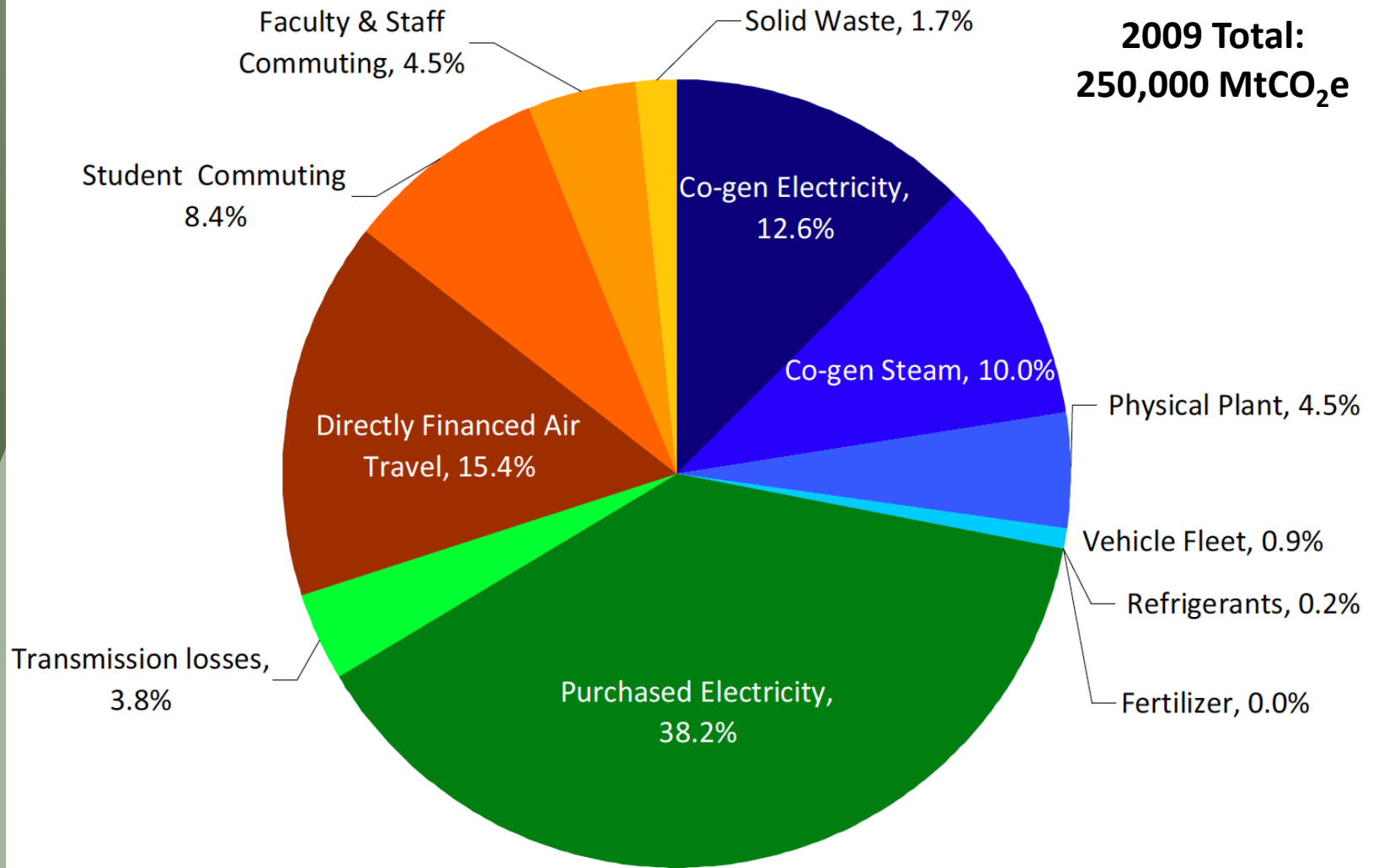


Sports Fields



UA GHG Inventory

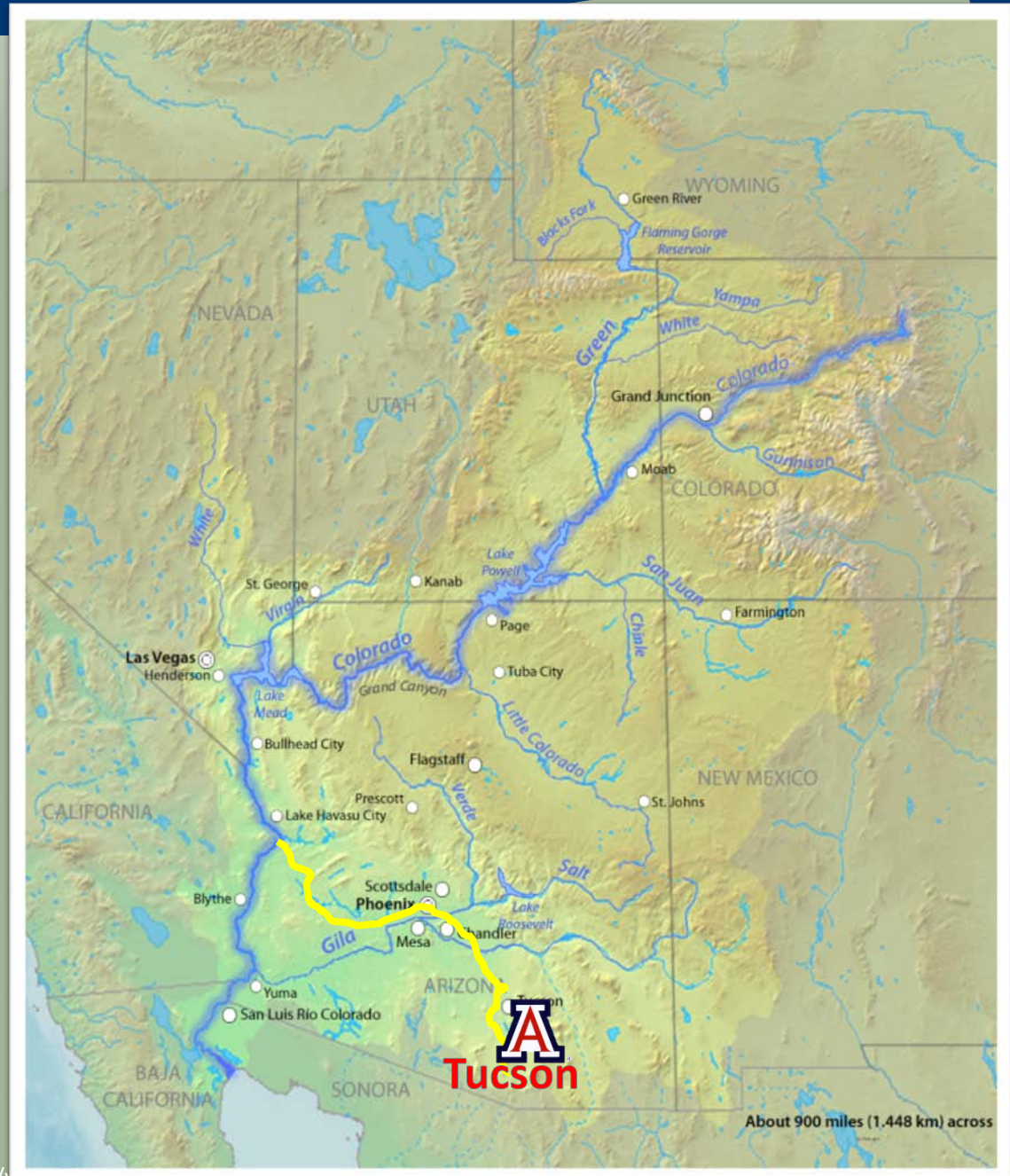
**2009 Total:
250,000 MtCO₂e**



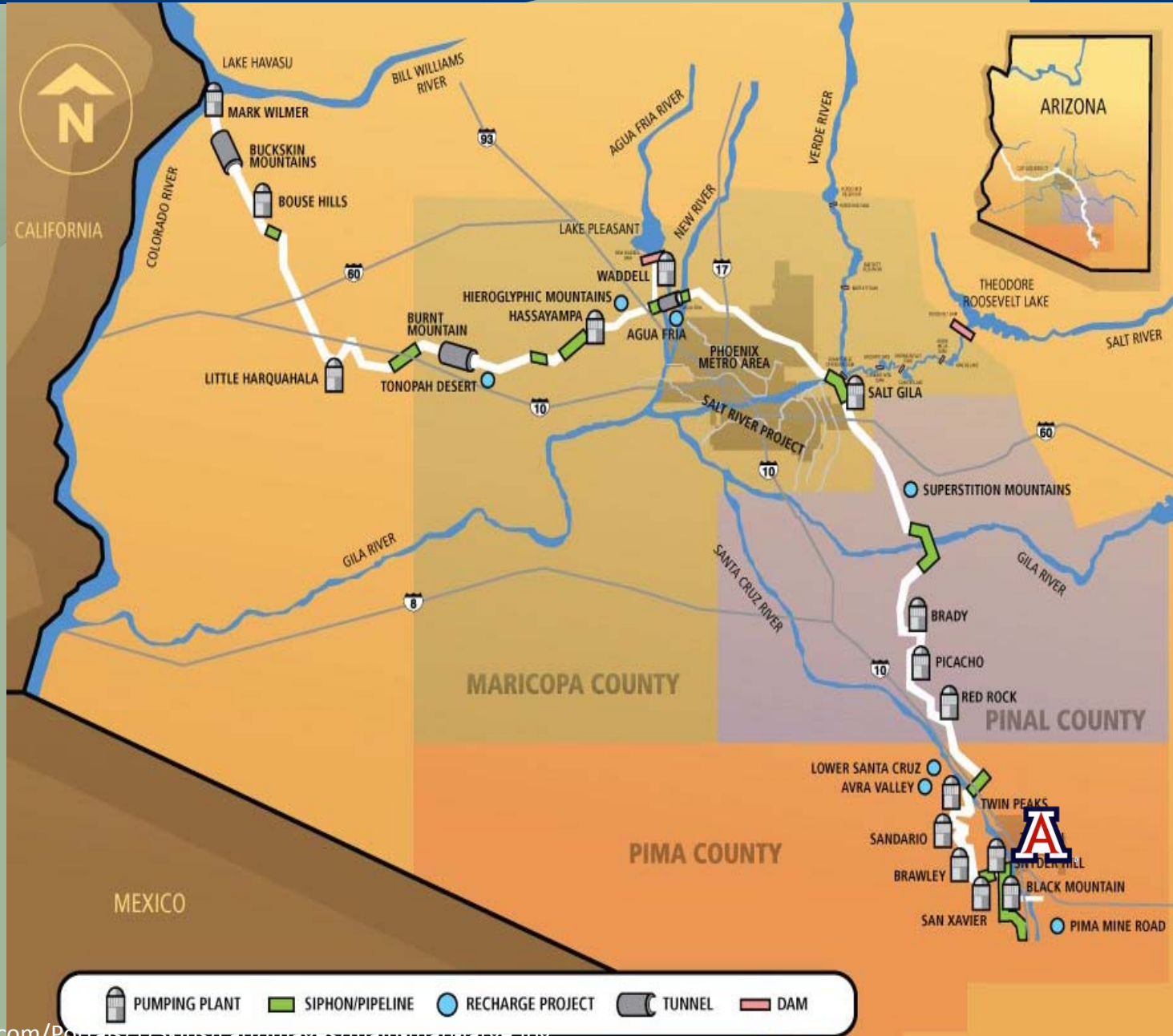
Sources of Water

- City of Tucson (COT) potable water
 - A blend of local groundwater & imported Colorado River water via the Central Arizona Project (CAP)
- UA wells
- COT Reclaimed water

Colorado River Basin



Central Arizona Project



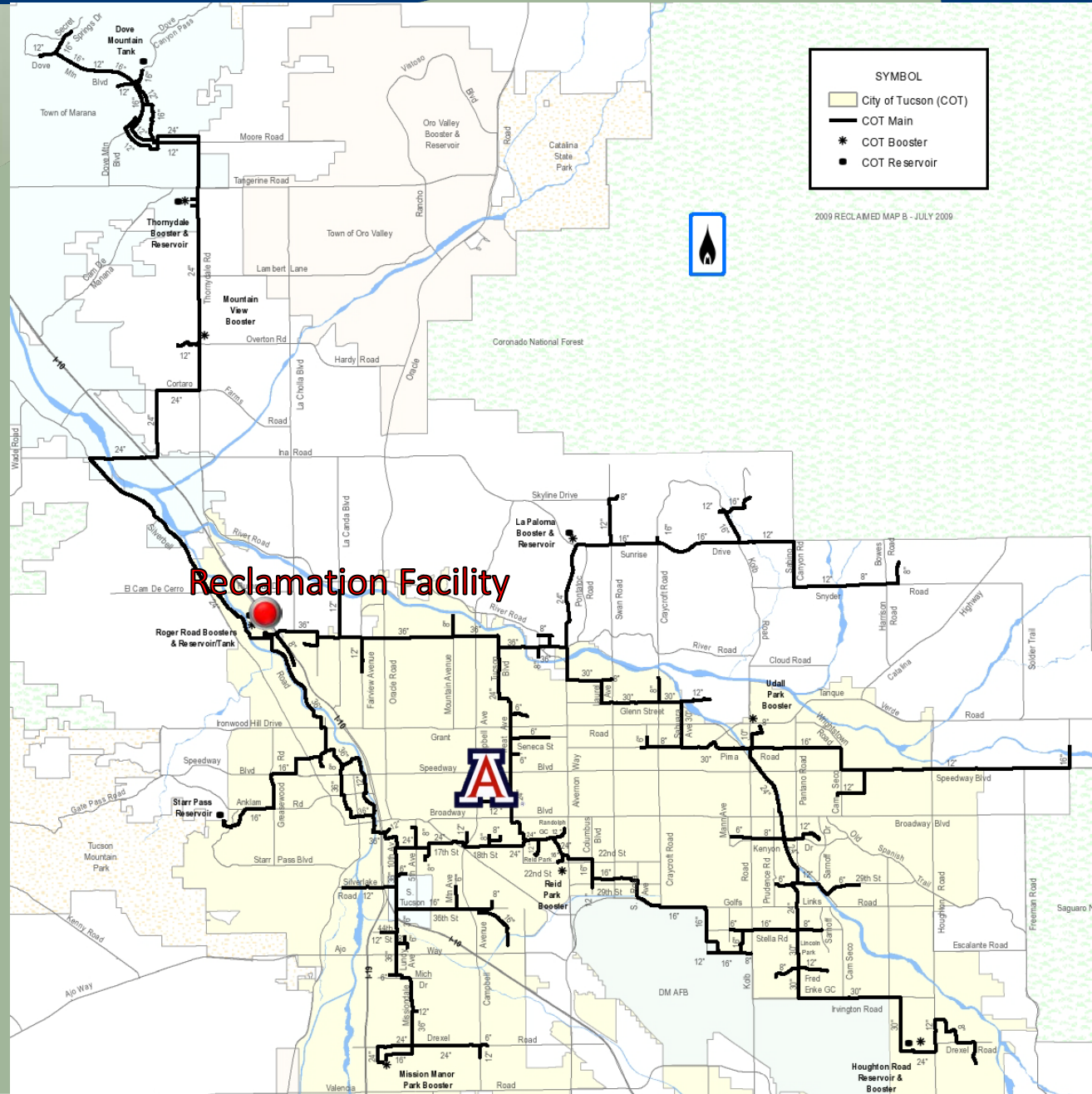
UA wells



Photo credit: Mark Marikos



City of Tucson Reclaimed Water System



Data

- Annual UA metered water volumes (1987 – 2010)
 - % from UA wells
 - % from City potable
 - % from City reclaimed
- Embedded energy in sources of water (MWh/Af)
 - Tucson Electric Power (80% coal 20% natural gas)
 - UA (100% natural gas)
 - Central Arizona Project (100% coal)
- Fuel-to-GHG emission Factors
 - Coal: 2249 lbs/MWh
 - Natural gas: 1135 lbs/MWh
 - Campus generators: 398 lbs/MWh

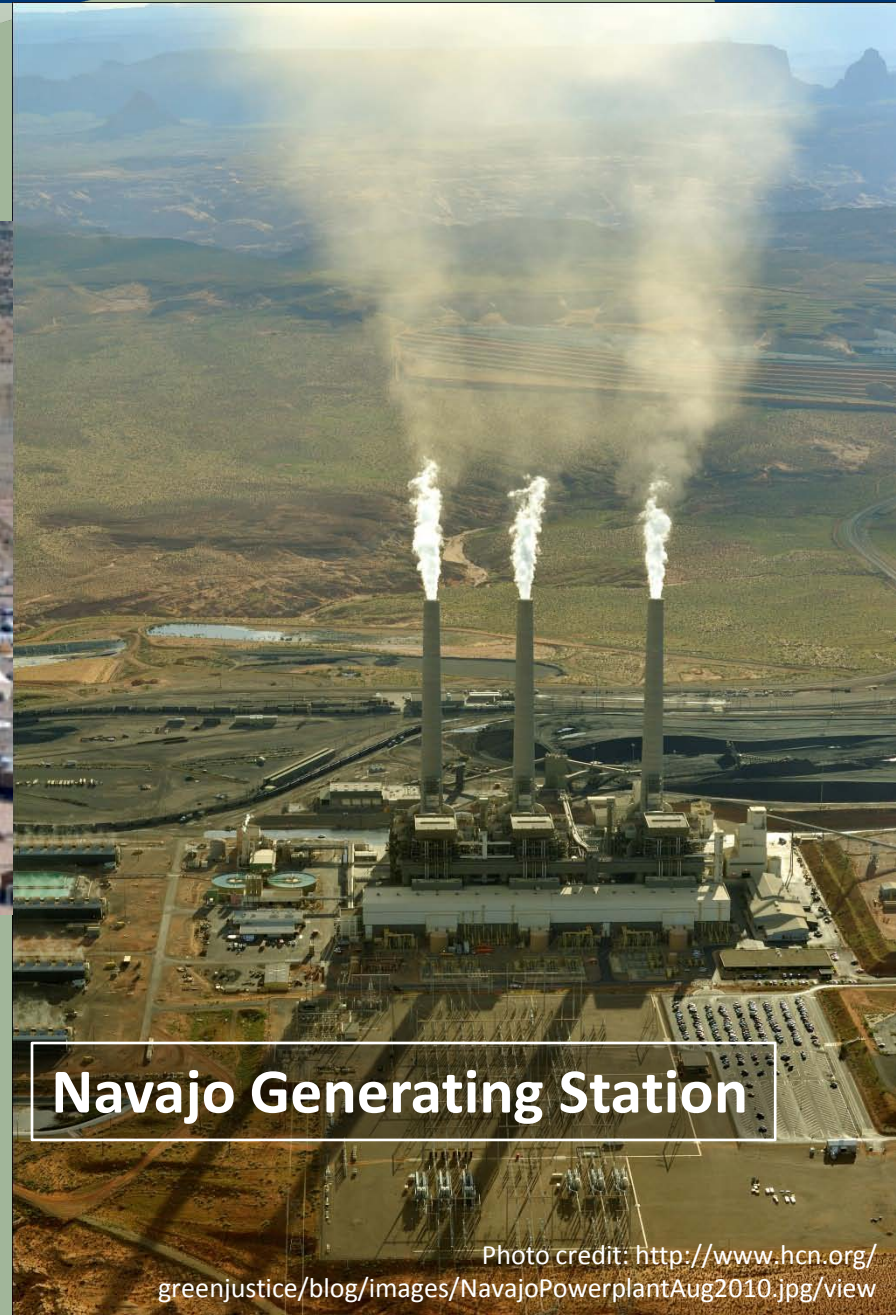
UA Gas Turbine Generators



Coal Power Plants

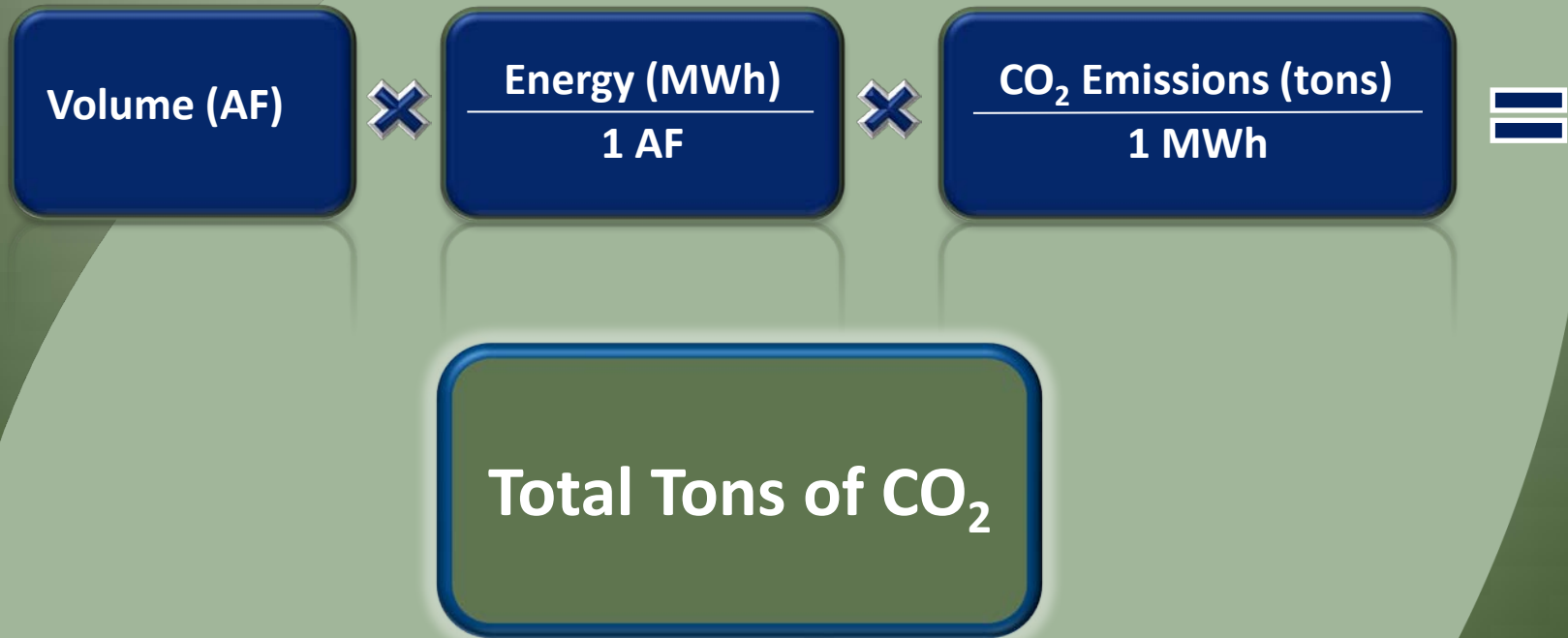


Springerville Generating Station



Navajo Generating Station

Method



Method

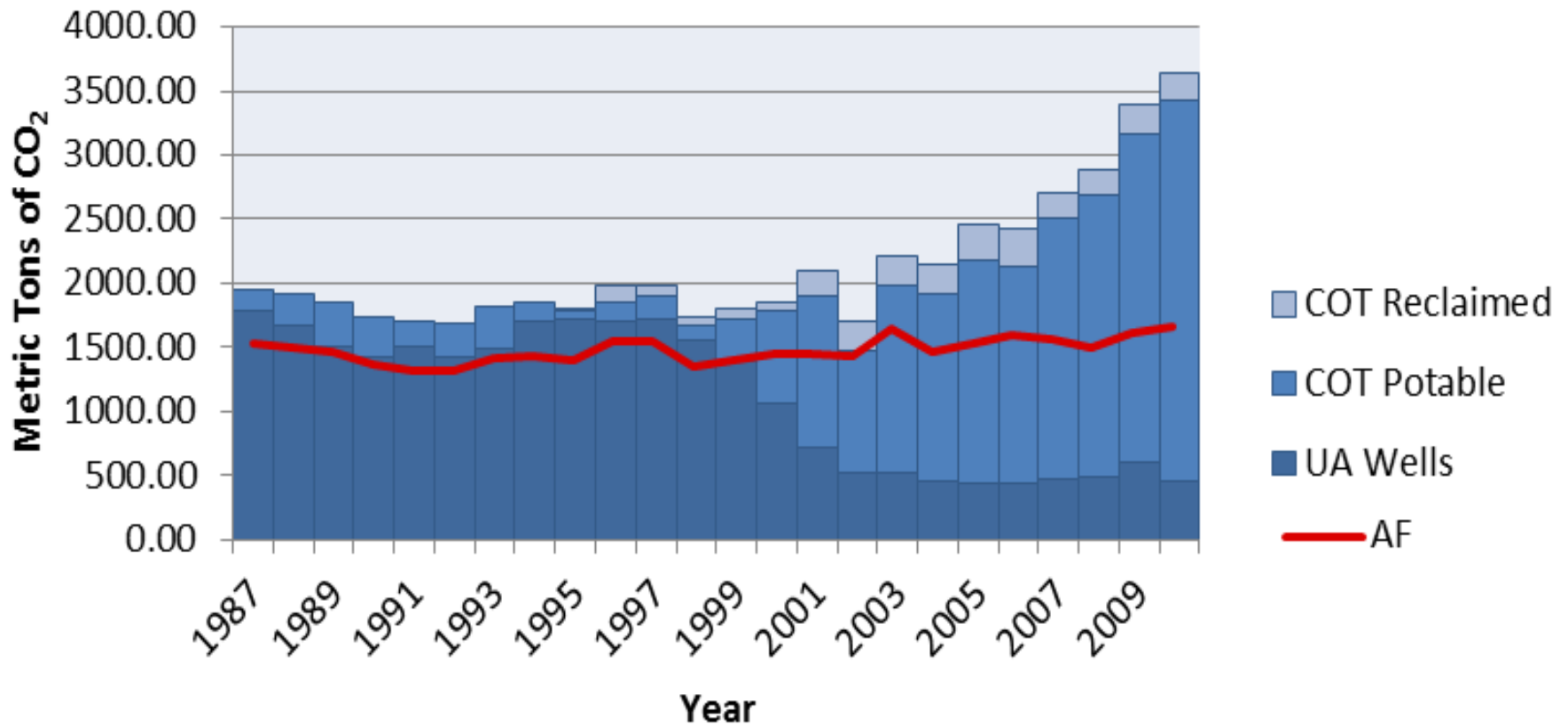
Equation for UA Wells

$$\begin{aligned}
 & \left(\begin{array}{l} \% \text{ Energy} \\ \text{from TEP} \end{array} \right) \left[\begin{array}{l} \left(AF \text{ of water} \times \frac{\text{energy (MWh)}}{AF} \times \left(\begin{array}{l} \% \text{ energy} \\ \text{from coal} \end{array} \right) \times \frac{\text{tons } CO_2}{\text{energy}} \right)_{\text{coal}} \\ + \left(AF \text{ of water} \times \frac{\text{energy (MWh)}}{AF} \times \left(\begin{array}{l} \% \text{ energy} \\ \text{from gas} \end{array} \right) \times \frac{\text{tons } CO_2}{\text{energy}} \right)_{\text{gas}} \end{array} \right] \\
 & + \left(\begin{array}{l} \% \text{ Energy} \\ \text{from UA generators} \end{array} \right) \left[AF \text{ of water} \times \frac{\text{energy (MWh)}}{AF} \times \frac{\text{tons } CO_2}{\text{energy}} \right] \\
 & =
 \end{aligned}$$

Total Tons of CO₂

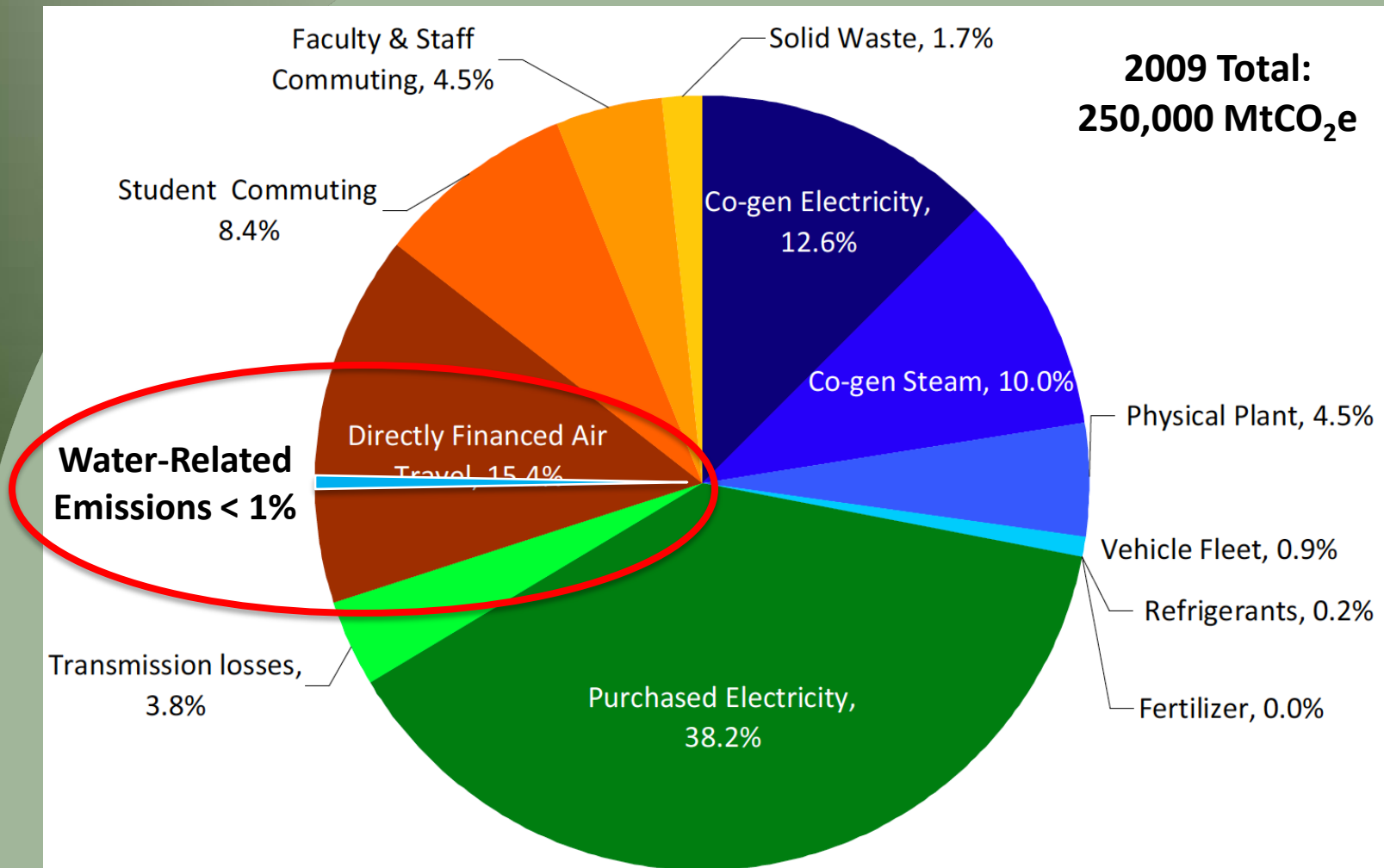
Results

CO₂ Emissions 1987-2010



Discussion

Water Conservation is a Limited GHG Strategy...



Discussion

Is Energy Part of the Water Conservation Message?

Flushing a 1.6 gal toilet = leaving a light bulb on for 0.45 milliseconds*



=



*WARNING: conversion is loaded with assumptions that are impossible to communicate

Discussion

How Does this Advance GHG Accounting?

TBD, but is an example of “bottom-up” accounting across organizational boundaries (CoT, CAP, UA, TEP)

“Top-Down”

- regional systems
- industry inventories
- national global inventories

Leverage existing data systems
Can be aggregated to larger scales

“Bottom-Up”

- facilities
- small businesses
- individuals

Provide more detailed analysis
Appropriate for regulatory frameworks
More difficult to aggregate

Acknowledgements

- Asia Philbin, Tucson Water
 - Energy usage numbers and emission rates for Tucson Potable and Reclaimed
- Marianne Deutsch, Senior Staff Technician for Utilities
 - Emission rates for UA Generators
- Mark Marikos, UA Facilities Management
 - Historic water volumes and images
- Mike Sheehan, TEP
 - Historic Emission Rates
- Joe Abraham, Office of Sustainability