Water Efficiency – Indoors

Rebuild Green Expo
Santa Rosa, CA
February 23, 2018

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The Water-Energy Nexus

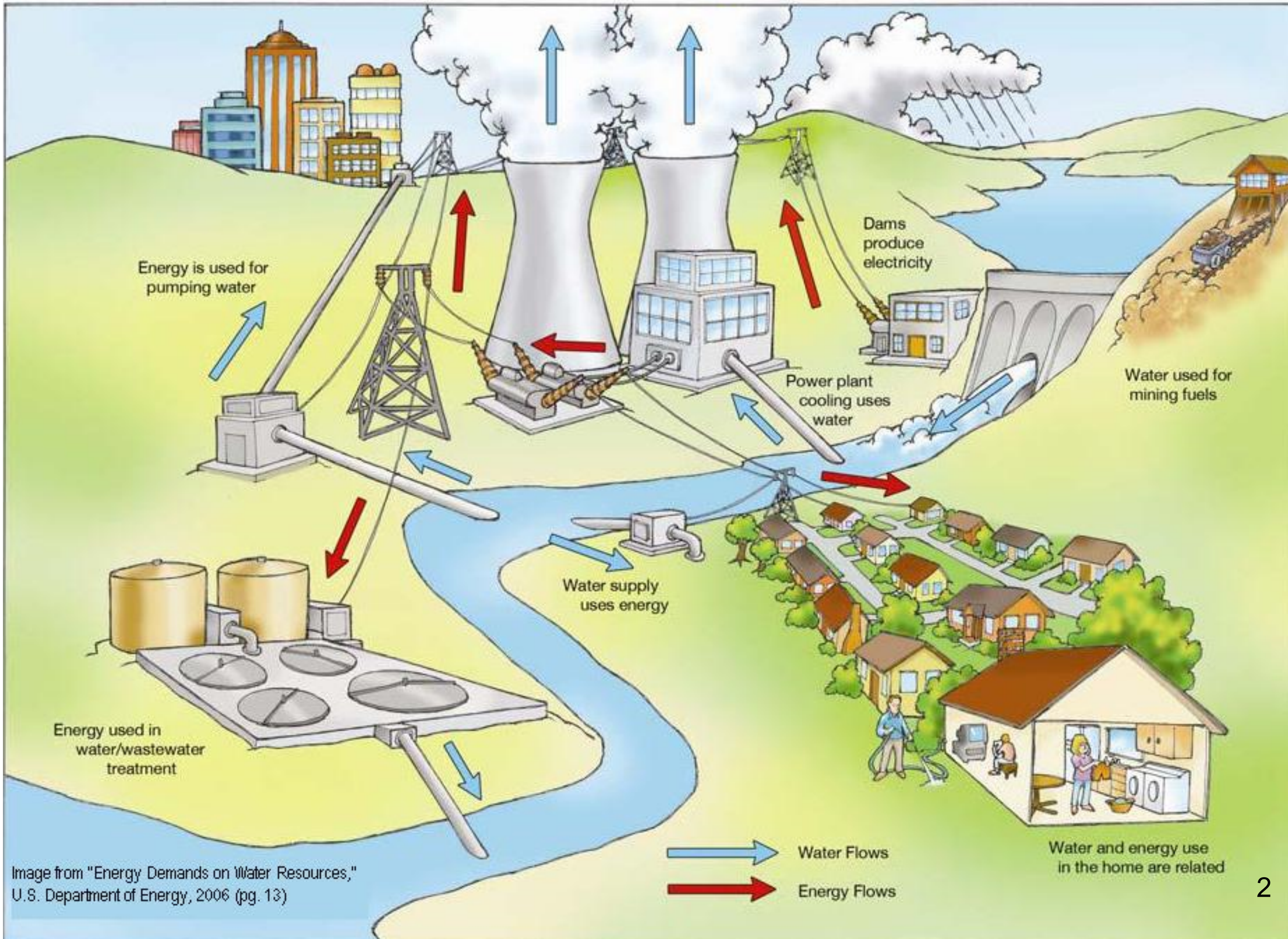


Image from "Energy Demands on Water Resources," U.S. Department of Energy, 2006 (pg. 13)

Water Embedded in Energy

Water *Consumption* per kWh

Power Provider	Gallons Evaporated per kWh at Thermoelectric Plants	Gallons Evaporated per kWh at Hydroelectric Plants	Weighted Gallons Evaporated per kWh of Site Energy
Western Interconnect	0.38 (1.4 L)	12.4 (47.0 L)	4.42 (16.7 L)
Eastern Interconnect	0.49 (1.9 L)	55.1 (208.5 L)	2.33 (8.8 L)
Texas Interconnect	0.44 (1.7 L)	0.0 (0 L)	0.43 (1.6 L)
U.S. Aggregate	0.47 (1.8 L)	18.0 (68 L)	2.00 (7.6 L)

"Consumptive Water Use for U.S. Power Production." National Renewable Energy Laboratory, 2003 http://www.nrel.gov/docs/fy04osti/33905.pdf

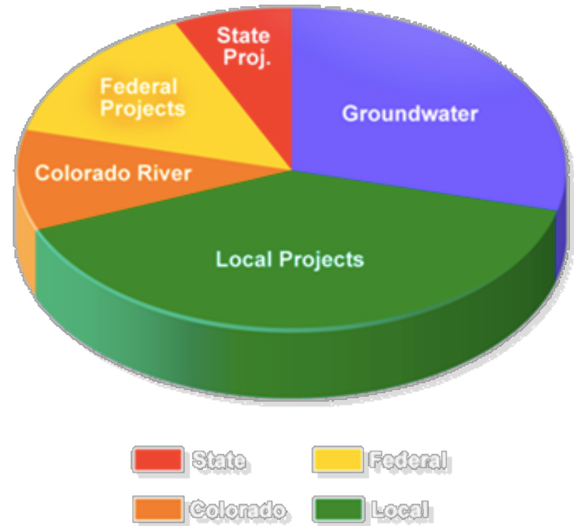
Water: Yet Another Reason to Push for Wind and Solar

Source	Gallons Per kWh
Wind	**0.001**
PV Solar	**0.030**
Nuclear	0.62
Coal	0.49
Oil	0.43
Hydro	18.27

Gipe, Paul. “Wind Energy Comes of Age,” 1995 http://www.awea.org/faq/water.html

Energy Embedded in Water

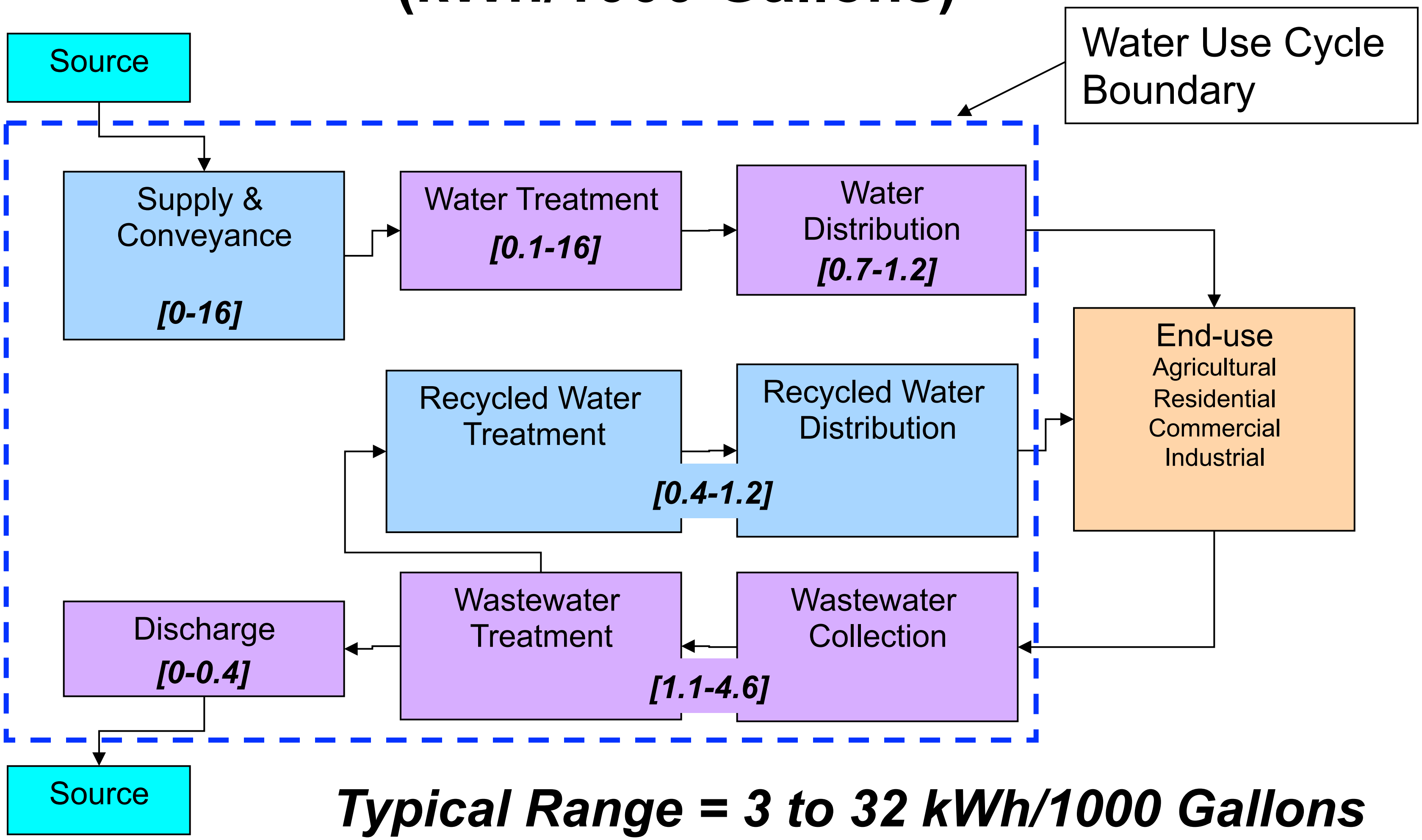
California's Water Supply Systems



Lester Snow, California Department of Water Resources

Water Use Cycle Energy Intensities

(kWh/1000 Gallons)



Typical Range = 3 to 32 kWh/1000 Gallons

Source: California Energy Commission, 2005 Integrated Energy Policy Report

Water-Related Energy Use-CA 2001

	Electricity (GWh)	Natural Gas (Million Therms)	Diesel (Million Gallons)
Urban Water Use Cycle			
Water Supply	7,554	19	?
Including Conveyance, Treatment and Distribution			
Wastewater	2,012	27	?
Including Collection, Treatment, Discharge and Recycled Water			
End Uses of Water			
Agriculture			
Supply to the Farm	3,188		
On-Farm Pumping	7,372	18	88
Residential	13,528	2,055	?
Commercial	8,341	250	?
Industrial	6,017	1,914	?
Totals	**48,012**	**4,283**	**88**
2001 Consumption	**250,494**	**13,571**	?
Percent of Energy Use	**19%**	**32%**	Small
CO_2 e (Million Metric Tons)	**56**	**50**	Small

Approximately 20-25 % of the nation's stationary energy use goes to water in some form.

Source: California Energy Commission, 2005 Integrated Energy Policy Report

Water-Related Energy Use-CA 2001 Another Perspective

	Electricity (GWh)	Natural Gas (Million Therms)	Diesel (Million Gallons)
Urban Water Use Cycle	9,566	46	
End Uses of Water			
Agriculture	10,560	18	88
Residential, Commercial, Industrial	27,886	4,219	
Totals	**48,012**	**4,283**	**88**
2001 Consumption	**250,494**	**13,571**	?
Percent of Energy Use			
All Water-Related Energy	19%	32%	Small
Urban Water Use Cycle	4%	0.3%	
Agriculture	4%	0.1%	Small
Residential, Commercial, Industrial	11%	31%	

Source: California Energy Commission, 2005 Integrated Energy Policy Report

Water Use Efficiency Strategies

- **Outdoor**
  - Landscape
  - Hardscape
- **Advanced Systems**
  - Graywater collection
  - Reclaimed water reuse
  - Rainwater collection and use
  - Mechanical Systems
- **Indoor**
  - Cold
  - Hot

Water Use Efficiency

- **Outdoor**
  - Landscape
    - Climate appropriate plant selection
    - Watering methods
    - ‘Need-based” controls
  - Hardscape
    - Solid
    - Porous

Water Use Efficiency

- **Advanced Systems**
  - Graywater
    - On-site collection and reuse
      - Separate drain lines
      - Separate delivery piping
  - Reclaimed water reuse
    - Outdoor or indoor use?
  - Rainwater collection and use
    - Outdoor or indoor use?
  - Mechanical Systems
    - Cooling towers
    - Condensate recovery

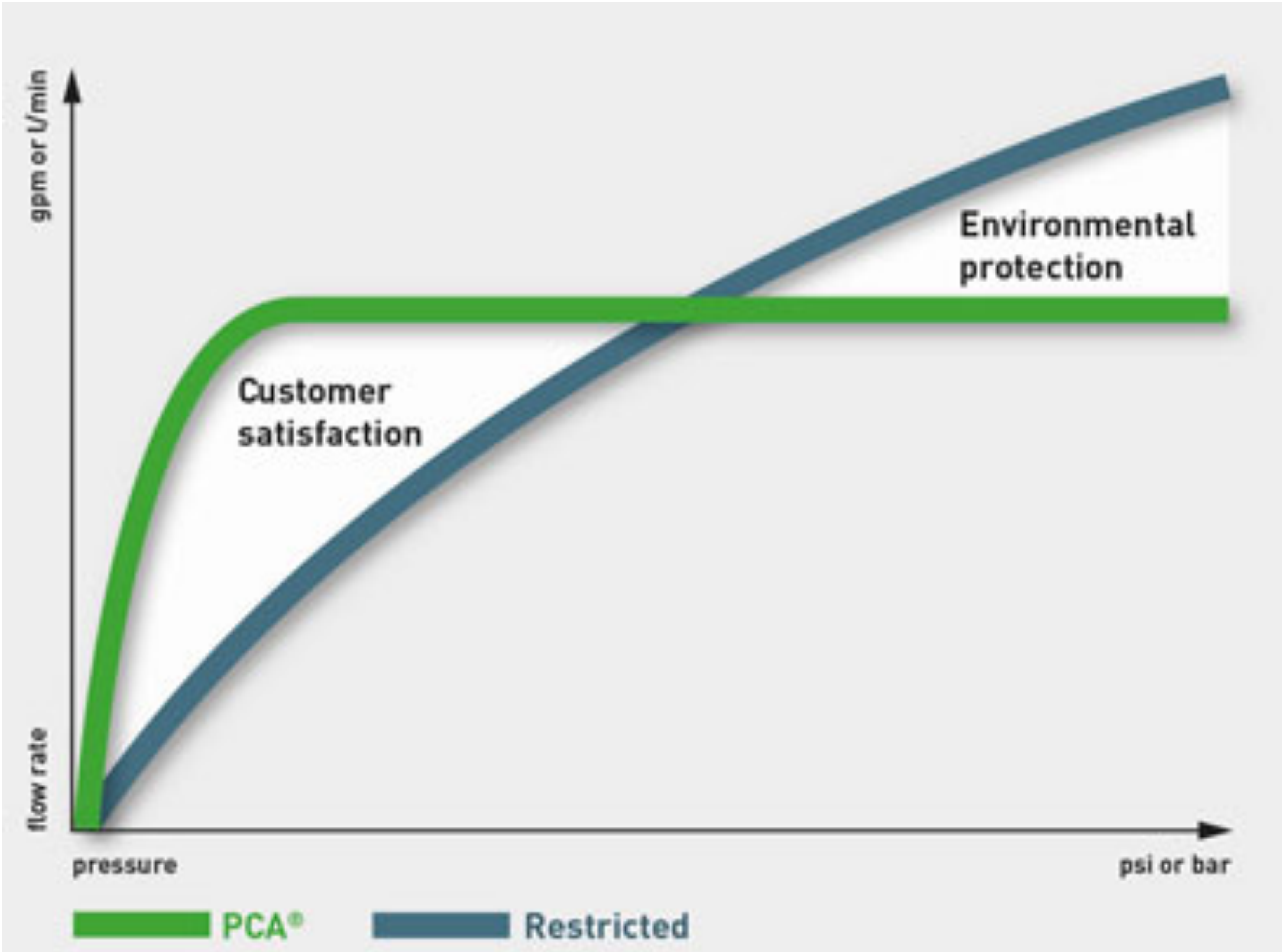
Water Use Efficiency

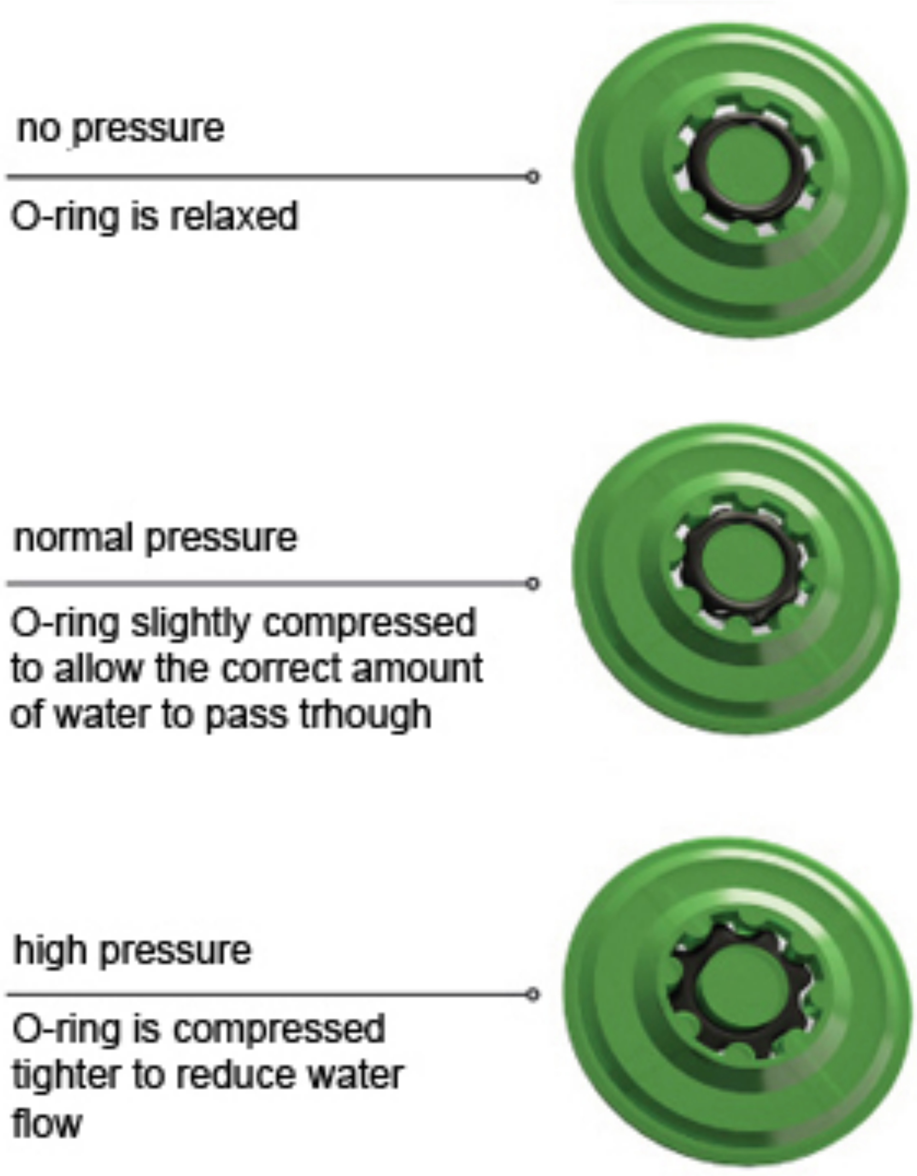
- **Indoor**
  - Cold
    - Toilets, Faucets, Aerators, Showerheads, Dish machines, Clothes washers, Ice machines
  - Hot
    - Wring out the Wastes
      - Improve hot water delivery
      - Capture waste heat running down the drain
      - Insulate hot water piping
    - Install water use efficient hot water devices
    - Select Water Heaters Compatible with WUE

Begin with the End in Mind

- What is the desired service?
- What is the load?

Pressure Compensating Aerators





Pressure compensating aerators

A pressure compensating flow regulator maintains a constant flow regardless of variations in line pressure thereby optimizing system performance and comfort of use at all pressures.

The next several slides were graciously provided by Ann V. Edminster www.annedminster.com

Plumbing Fixture Resources & Terms

gpm:
gallons per minute

gpf:
gallons per flush

www.epa.gov/WaterSense/
products/

Showerheads

- ≤ 1.8 gpm after July 1, 2018
- GPM isn't the whole story; hydraulic design determines performance
- Thermostatic Shut-off Valves
- Specify pressure compensating
- Read the reviews: http://www.housetalkgreen.com/new-showerhead-test-results/

Faucets

- Kitchen ≤ 1.8 gpm with optional temporary flow of 2.2 gpm
- Private Lavatory ≤ 1.2 gpm
- Public lavatory ≤ 0.5 gpm
- Specify pressure compensating aerators

High-efficiency Toilets (HETs)

- Toilets ≤ 1.28 gpf
- "Best" ≤ 0.8 gpf
- And where appropriate:
  - Composting toilets
  - Urinals
  - Bidet seats

Dual-flush models:
gpf = average of
(2x #1) + (1x #2)

Appliance Resources

http://enervee.com/

www.toptenusa.org

http://aceee.org/sector/residential

http://library.cee1.org/content/cee-super-efficient-home-appliance-initiative-2014/

https://www.energystar.gov/index.cfm?c=most_efficient.me_index

Efficient Clothes Washers

- **NOT JUST Energy Star –**
  - Modified Energy Factor (EF) ≥1.8
  - Water Factor (WF) ≤ 7.5
- **Front-loading**
- **Automatic water level control**
- **Multiple wash/rinse temperature options**

Efficient Dishwashers

- **NOT JUST Energy Star –**
  - Energy Factor (EF) ≥0.75
  - Water Factor (WF) < 4.25
- **Wash cycles: more = better**
- **No-heat dry option**
- **Can it connect to cold water?**

Why Do I Work on Hot Water?

- Energy Intensity of Indoor Cold Water
  - Range from 3 to 32 kWh per 1000 gallons
- Energy Intensity of Hot Water

	Electric		Natural Gas	
	Resistance (85 % Efficient)	Heat Pump (COP = 2)	(50% Efficient)	(95% Efficient)
kWh/1,000 Gallons	201	85	342	180
Relative Energy Intensity compared to 5 kWh/1,000 gallons	40	17	68	36

- Typically 40-68 times more energy intensive than indoor cold water.

The most valuable water to conserve is hot water
at the top of the tallest building,
with the highest elevation,
in the area with the greatest pressure drop.

The Aha! Moment

- Up until 2014 energy models had very limited abilities.
- Only a few had the ability to adjust hot water volume and therefore the energy needed for water heating.
- None had the ability to properly account for measures that increased the efficiency of hot water use.

First Count the Water, then Count the Energy

SoCalGas Hot Water Demonstration Lab

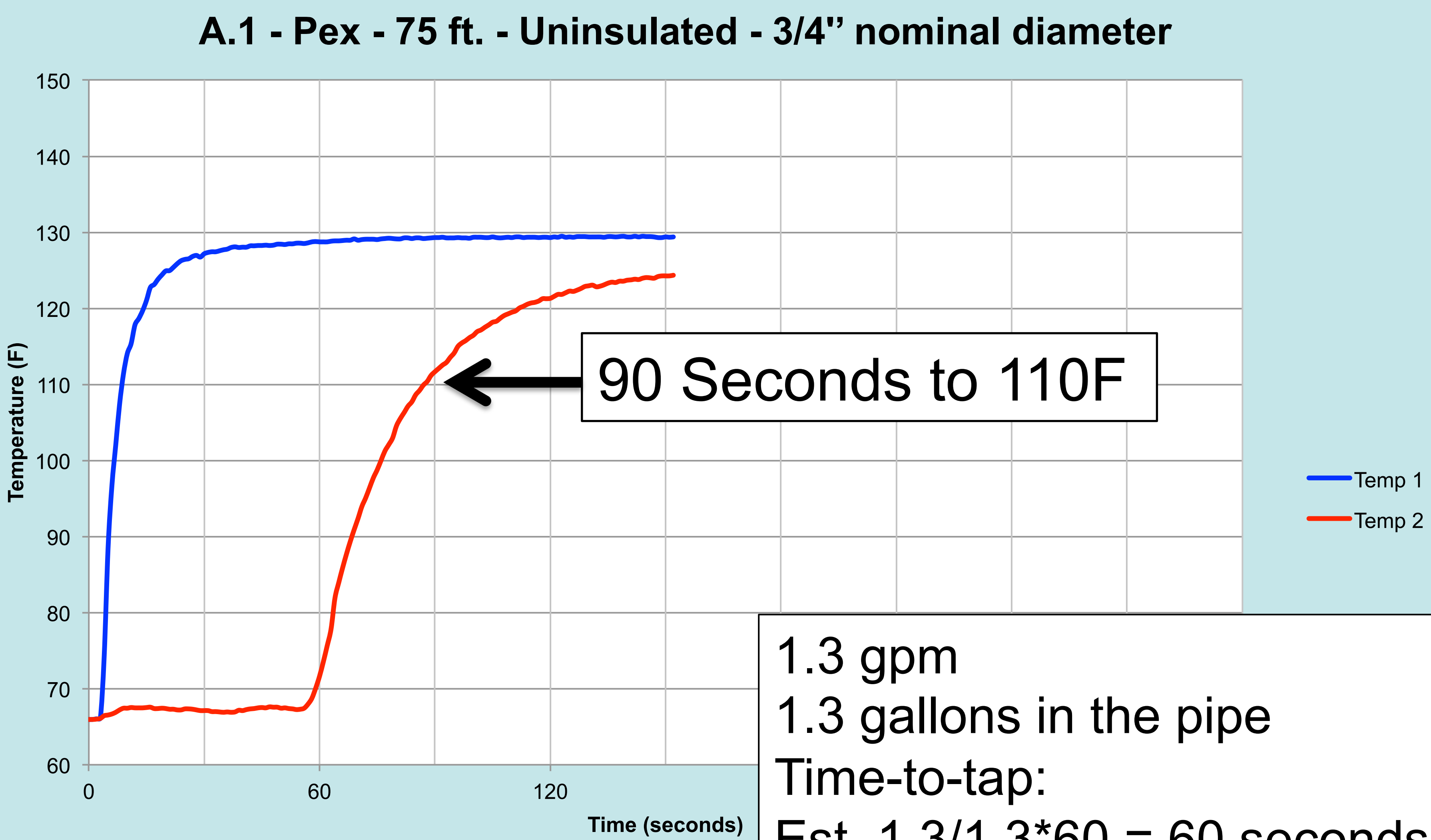
Entering Section of Experiment:

1. Flushing and Priming
2. Flow Rate
3. Pressure 1
4. Temperature 1

Exiting Section of Experiment:

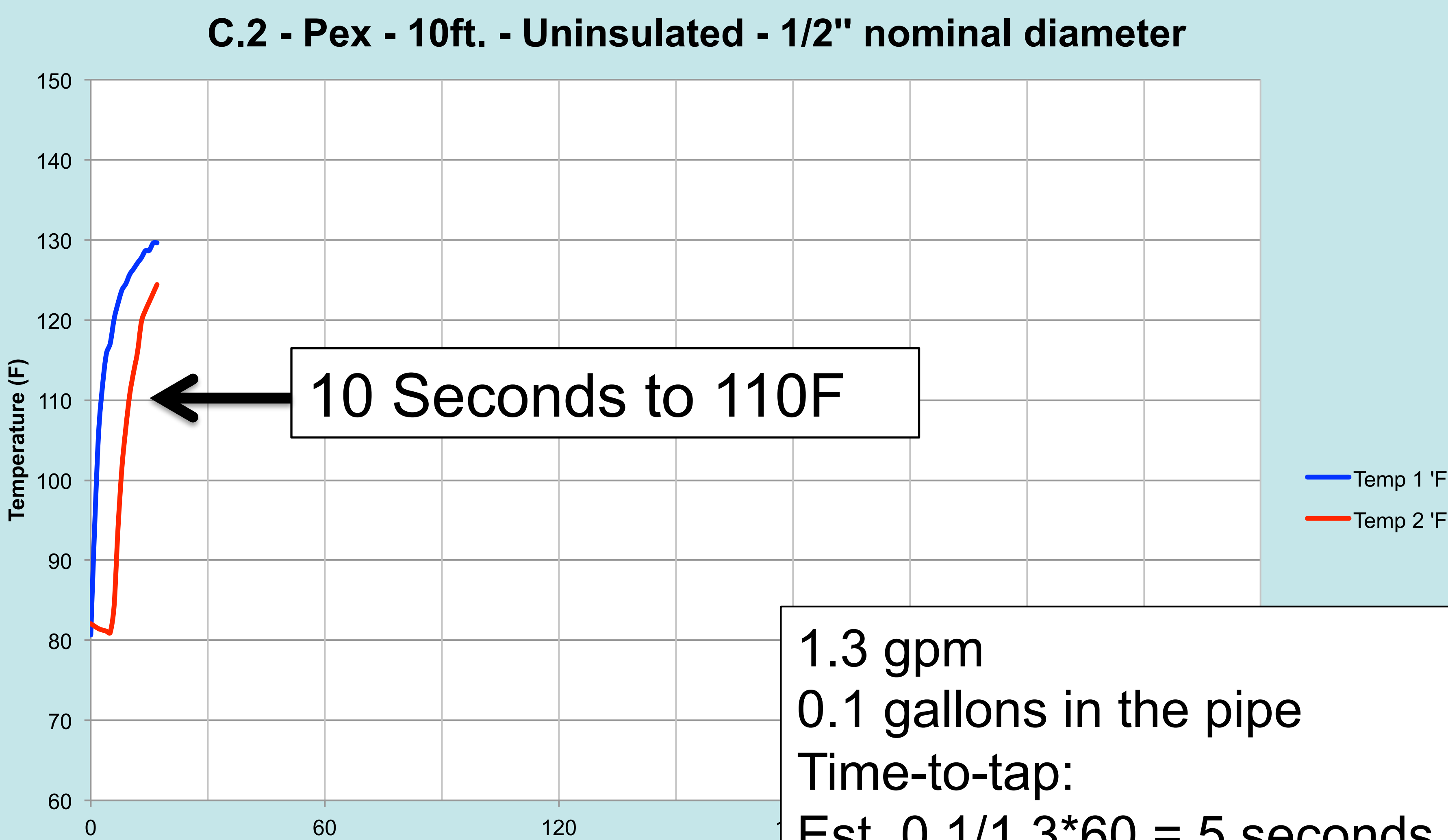
1. Pressure 2
2. Temperature 2
3. Discharge through Plumbing Fixture

Demonstrating Performance



1.3 gpm
1.3 gallons in the pipe
Time-to-tap:
Est. 1.3/1.3*60 = 60 seconds
Why 30 seconds more?

Demonstrating Performance



1.3 gpm
0.1 gallons in the pipe
Time-to-tap:
Est. 0.1/1.3*60 = 5 seconds
Why 5 seconds more?

Length of Pipe that Holds 8 oz of Water

	3/8" CTS	1/2" CTS	3/4" CTS	1" CTS
	ft/cup	ft/cup	ft/cup	ft/cup
"K" copper	9.48	5.52	2.76	1.55
"L" copper	7.92	5.16	2.49	1.46
"M" copper	7.57	4.73	2.33	1.38
CPVC	N/A	6.41	3.00	1.81
PEX	12.09	6.62	3.34	2.02
Ave	**8 feet**	**5 feet**	**2.5 feet**	**1.5 feet**

How Long Should We Wait?

Volume in the Pipe (ounces)	Minimum Time-to-Tap (seconds) at Selected Flow Rates					
	0.25 gpm	0.5 gpm	1 gpm	1.5 gpm	2 gpm	2.5 gpm
2	4	1.9	0.9	0.6	0.5	0.4
4	8	4	1.9	1.3	0.9	0.8
8	15	8	4	2.5	1.9	1.5
16	30	15	8	5	4	3
24	45	23	11	8	6	5
32	60	30	15	10	8	6
64	120	60	30	20	15	12
128	240	120	60	40	30	24

ASPE Time-to-Tap Performance Criteria

	Acceptable Performance	1 – 10 seconds
	Marginal Performance	11 – 30 seconds
	Unacceptable Performance	31+ seconds

Source: Domestic Water Heating Design Manual – 2nd Edition, ASPE, 2003, page 234

Water-Energy Relationship: Synergies

- ✓End-User Water and Energy Conservation
  - ✓ Saving water can save energy
  - ✓ Saving energy can save water
- ✓Water and Wastewater Utility Operational Efficiency
  - ✓ Increasing water and wastewater system efficiency reduces energy in the water use cycle
- ✓Water Storage
  - ✓ Increased water storage and more flexible water storage shifts peak energy requirements
  - ✓ Pumped storage increases peak electric generation and improves electric system efficiency
- ✓Improve Price Signals
  - ✓ Time of use water rates and meters
  - ✓ Time of use electric rates and meters
- ✓Renewable Generation by Water and Wastewater Utilities
  - ✓ Increase generation from in-conduit hydro and biogas. Add generation from solar and wind.
  - ✓ Assist in meeting California's renewable generation goals

If we did all this,

what would be the combined impact on GHG emissions?

The Unintended Consequences of Increasing Water Use Efficiency

Given human nature,
it is our job
to provide the infrastructure
that supports efficient behaviors.

Thank You!

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