

# This presentation premiered at WaterSmart Innovations

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# Re-Thinking Re-Cycling:

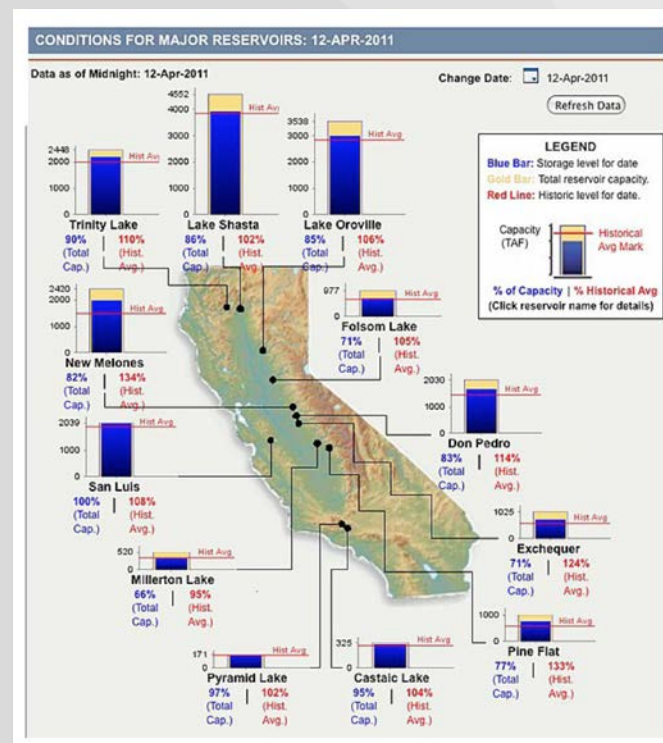
Taking Residential Water Efficiency to New Heights -  
Integration of Rainwater & Grey Water Harvesting

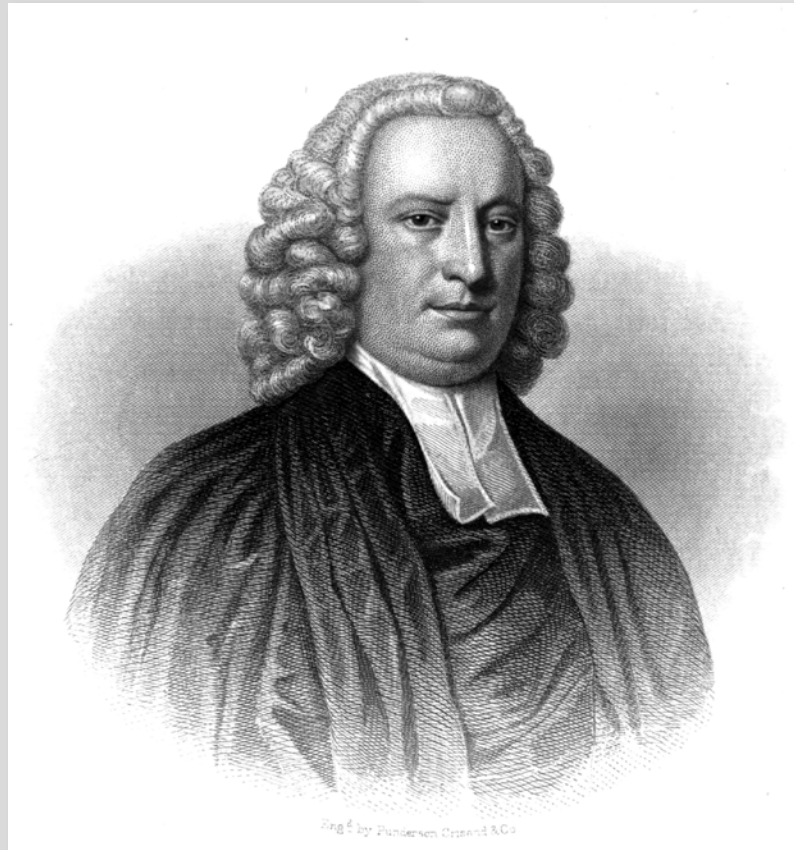
# Why Re-Think Re-Cycling?

## Three Good Reasons

- The Drought
- The Drought
- The Drought

We need “Enlightenment”

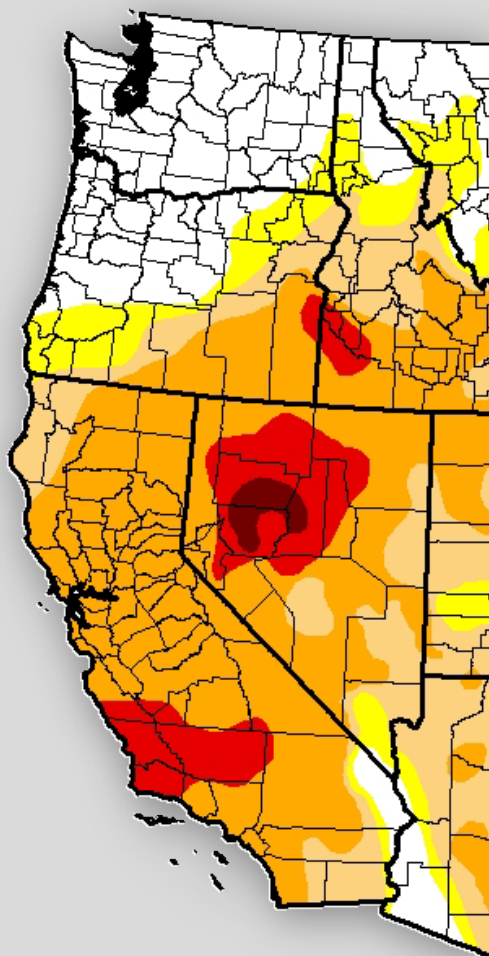




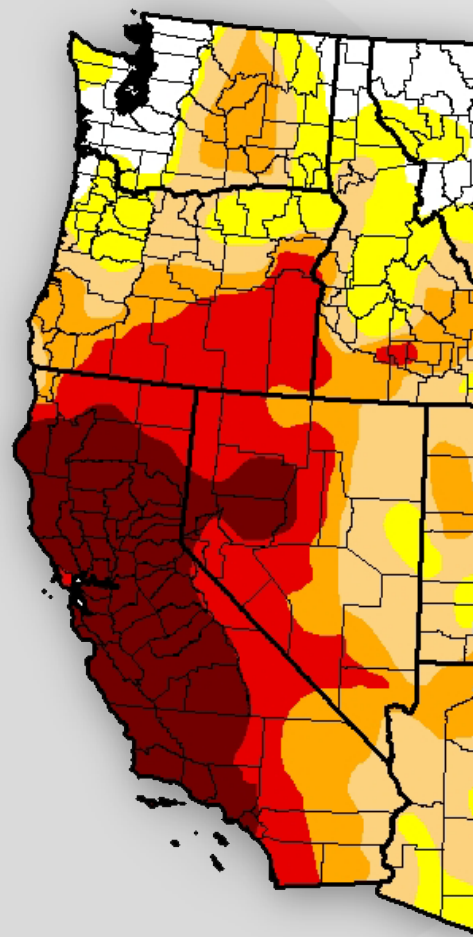
*"When a man has the certain knowledge he is to be hanged in the morning, it concentrates his mind wonderfully"*

-Dr Samuel Johnson

# A Comparison Of Drought Maps



2013



2014



*"We shall all know the value of water when the well runs dry."*

*"To Fail to Prepare - is to Prepare to Fail"*

**WWBFD -What would Ben Franklin do?**

*"A gallon saved is a gallon earned"*

*"Your well is running dry - and you're watering your lawns and flushing your toilets with drinking water? There's got to be a better way!"*

# What Should Be Recycled?

## Treated Wastewater:

- Refill our wells?
- Irrigate public greenspace?
- ~~Pump it to the homes?~~

## Grey water:

- Untreated?
- Partially Treated?
- Highly Treated?

## Rainwater:

- What level of treatment?

## Something Else?



# Centralized vs Decentralized





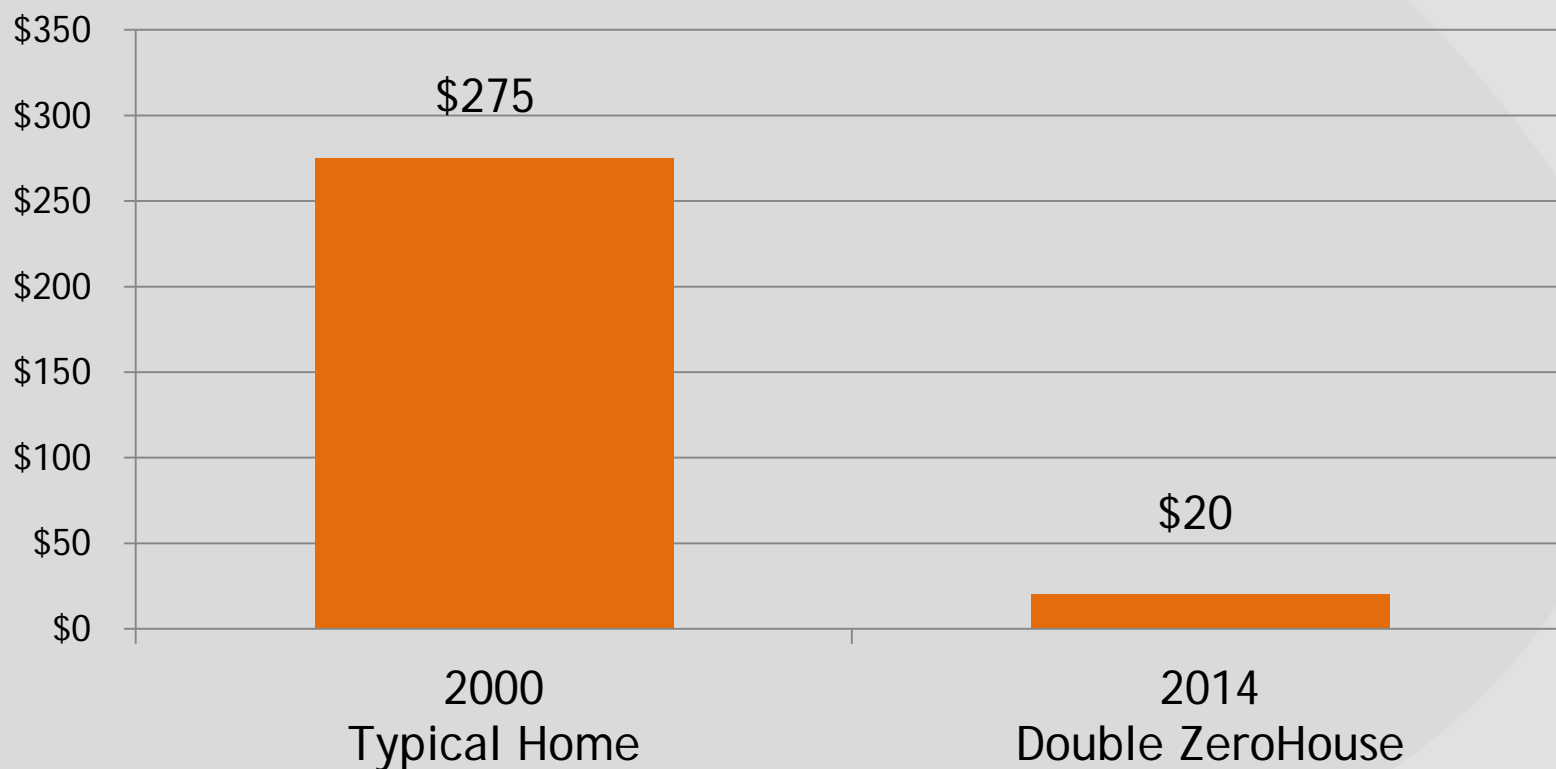
# Centralized vs Decentralized



The Solution to most sustainability issues is *On-Site Solutions*

# Benchmark: Decentralized Energy

Monthly Energy Cost, New Home



# Recycled Water in the Home: Centralized vs On-Site Water Recycling

	ON-SITE RECYCLING	CENTRALIZED RECYCLING
Source of water	Grey water (same home)	Sewage
Odor of treated water	No	Yes
New homes universe - 2015	100%	<1%
Retrofit universe - Share of homes	40% of SFH	?
2015 potential savings (AF)	6,500 AF	110 AF
Homeowner engagement	Yes	None
Homeowner acceptability	High	Questionable
Capital cost	Low	High
Construction impact on traffic	None	High
Timelag -- Planning -to-implementation	Months	Years
Treatment standard	NSF-350	Title 22

# ANSI/NSF 350 vs Title 22

## Roughly Equivalent

Measure	NSF350 Standard - Class R (residential)		Tertiary Discharge/Title 22	
	Test Average	Single Sample Maximum	Average	Max
CBOD (mg/L)	10	25	10 <sup>1</sup>	Na
TSS (mg/L)	10	30	10 <sup>1</sup>	Na
Turbidity (mg/L)	5	10	2 <sup>2</sup>	Na
E. Coli (MPN/100mL)	14	240	2.2 <sup>2</sup>	23
pH	6.0 - 9.0	Na	6.0 - 9.0	Na
Storage vessel disinfection (mg/L)	$\geq 0.5 - \leq 2.5$	Na	Na	Na

# Why Think About Grey Water & Rain Water Integration Now?

- Highest impact “Alternate sources of water”
- Treated grey water, untreated grey water, and rainwater all now recognized in California Plumbing Code
- Alternate sources become “new water” as drought worsens
- New upgrade fund sources in process – CA AB 2636 revolving low interest fund

# Why We Started With Grey Water

- Very high volume supply: 2 out of 3 gallons indoor water 'get a second lease on life'
- Consistent supply - daily throughout year
- Drought-time performance -- Excellent
- Very high yield -- Supply rarely exceeds demand
- Grey water can become 'Greyless' water: Near-Title 22 water quality can be obtained at low cost



# NEXtreater makes NEXwater

- looks and smells like tap water
- NSF 350 grey water approved in California as of January 1 for indoor reuse and above ground lawn watering



# What We Learned In The Field

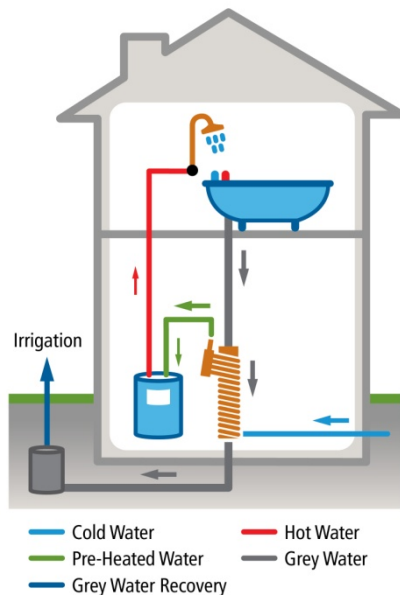
- Unquenchable thirst for non-potable water and/or conservation
- Outdoor water budgets have biggest impact
- “Zero Potable Water for Irrigation” *almost* achievable with grey water alone
- NRDC 25 x 25 *almost* achievable today
- Hypothesis: Homeowner engagement is key to long-term drought solution



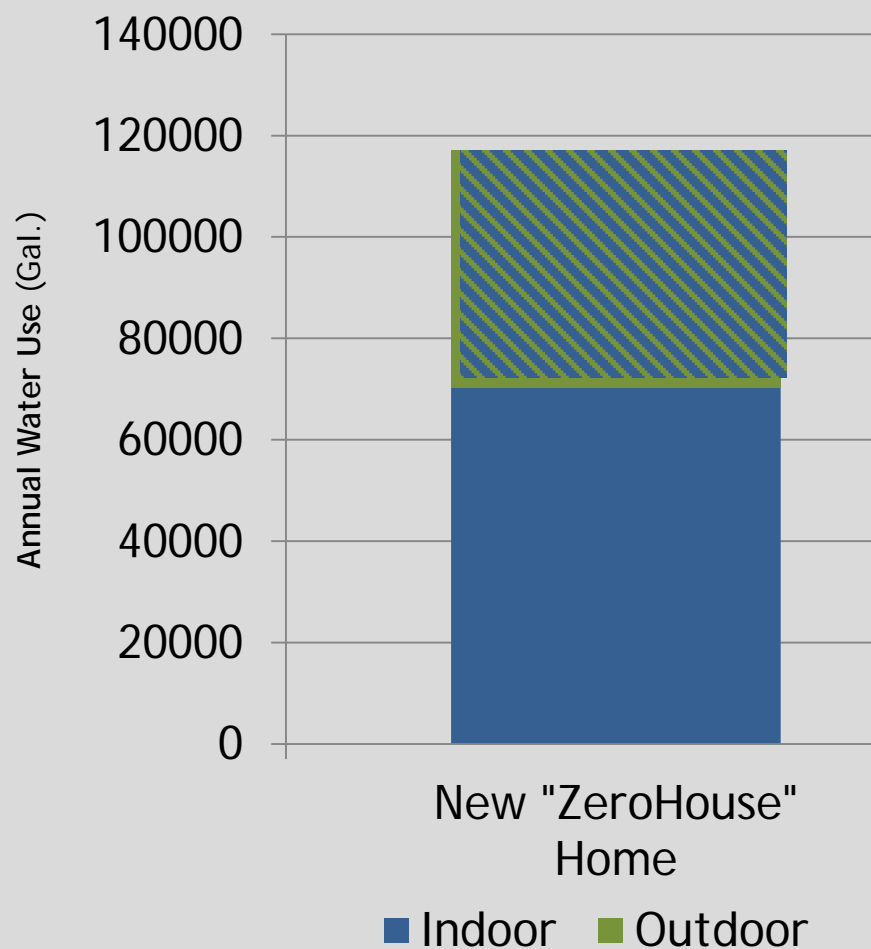
BUILT TO ORDER

# zeroHOUSE 2.0

- Production home in Lancaster CA
- Goal: Zero City Water for Irrigation
- Strategy: Low-water landscape + Grey Water Recycling
- 2 of 3 gallons indoor water treated/recycled on-site
- 40,000 gallons recycled water annually



# Same Home, but Different



# Why Integrate Rain Water Into Grey Water?

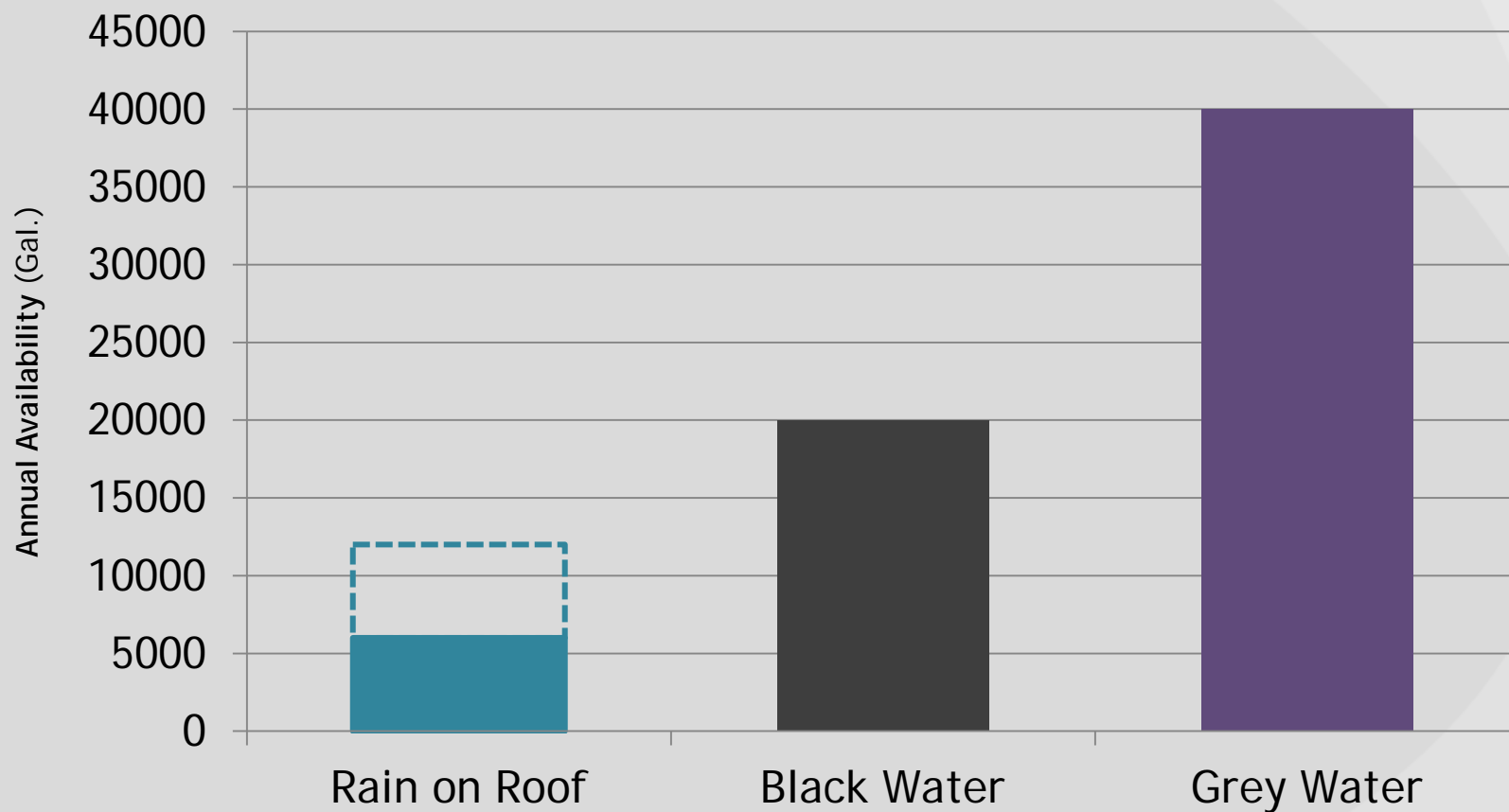
- More efficiency needed to address the drought - what source?
- Rain water is the second best Alternate Water Source in the Southwest
- Technologically, can be integrated with grey water as single system
- Integrated solution is better than two independent solutions
- Issues are in the code (and manageable), not in the technology

# Key Budget Planning Numbers

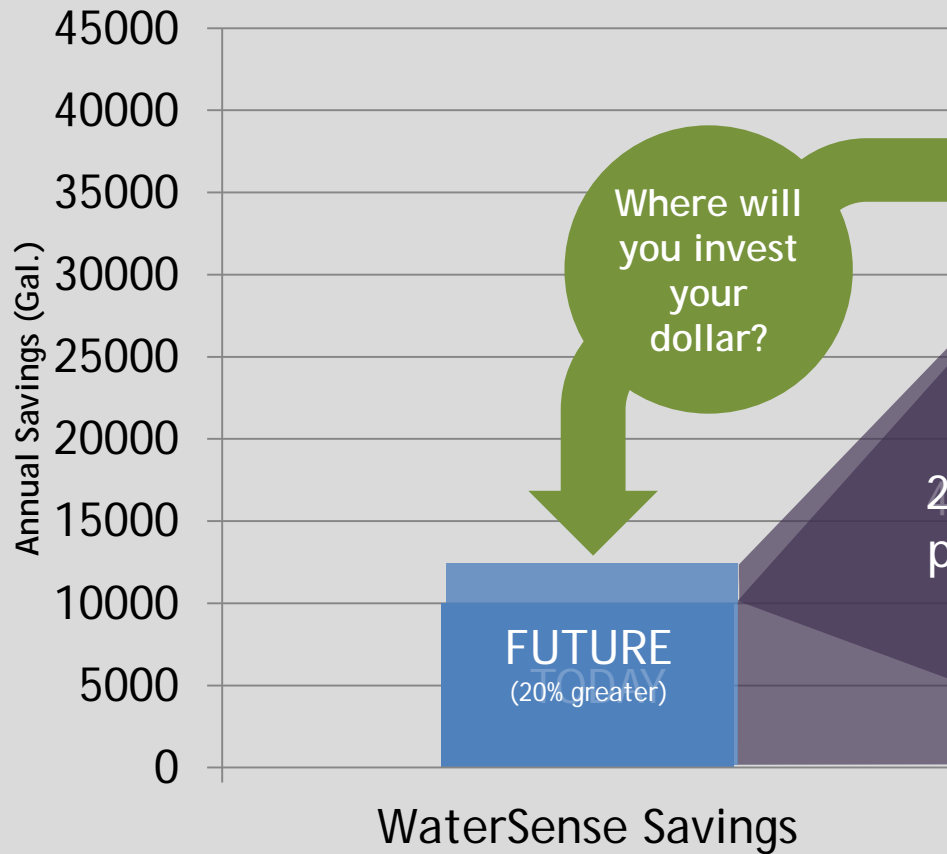
- 2 out of 3 gallons of Indoor Water is recyclable - 30 gallons/person/day (WaterSense Fixtures)
- 40,000+ gallons annually in Family of 4
- Rainwater production: 600~1200 gallons/inch on typical roof (1,000~2,000 sq ft)
- Low-Water Model Landscape: 38,000 gallons annually (avg 104g/day)
- Toilet flush water: 6~9 gallons/day/person (avg 30 G/day in Family of 4)
- Non-potable water budget for Fam-4: 49,000 gallons



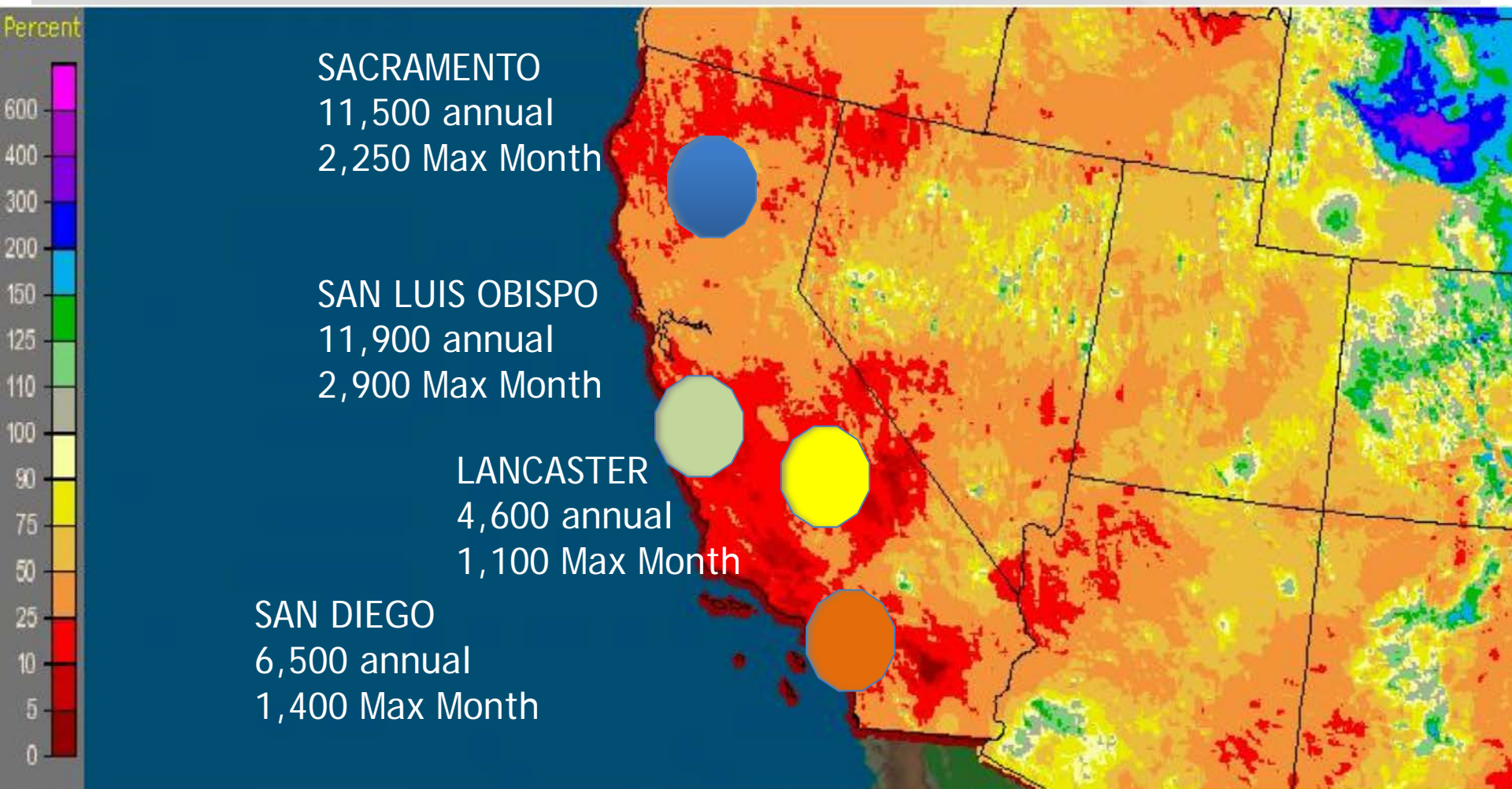
# Your Sources of On-Site Water



# Greywater Recycling: The Ultimate HED?



# California Rainwater Potential: More Seasonal Than Geographic Variance



*\*Valid at 2/13/14*

	Treated Grey Water (Home Water Recycling)	Rain Water	Untreated Grey Water
Certification standard	NSF/ANSI 350	none	none
Allowed non-potable applications	All irrigation, Toilet flushing	All irrigation, Toilet flushing	Sub-surface irrigation of shrubs/lawns (no edible root plants) <b>No toilets</b>
Drought-time performance	Excellent	<b>Terrible</b>	Excellent
Water Quality	Excellent when treated	Excellent with filtration + disinfection	<b>Highly Variable; Health Concerns</b>
Challenge	<b>Retrofits on slab foundations</b>	Accessing entire roof; storing peak volumes	<b>Cannot be stored &gt;24 hrs</b>

# Performance Characteristics Summarized

	Treated Grey Water	Rain Water
Dependent on	Occupancy	Weather
Consistency	Consistent year-round	Highly variable
Drought-time performance	Excellent	Terrible
Water Quality	Excellent when treated	Excellent with limited treatment
Rule of Thumb	30 gallons/person/day	600-1200 gallons/inch

# California Code Treatment Compared

	Treated Grey Water	Rain Water
Filtration requirement		
Disinfection	<u>Required</u> to control pathogens	Not required, but <u>preferred</u> for long-term storage
Top-up issues (cross connection)	Inlet air gap must be above grade	Inlet air gap must be above grade
Storage Tank Overflows	<u>Must be able to</u> overflow to sewer	<u>Not permitted to</u> overflow to sewer
Commingling with other "Alternate Water"	Not stipulated in Code	Not stipulated in Code

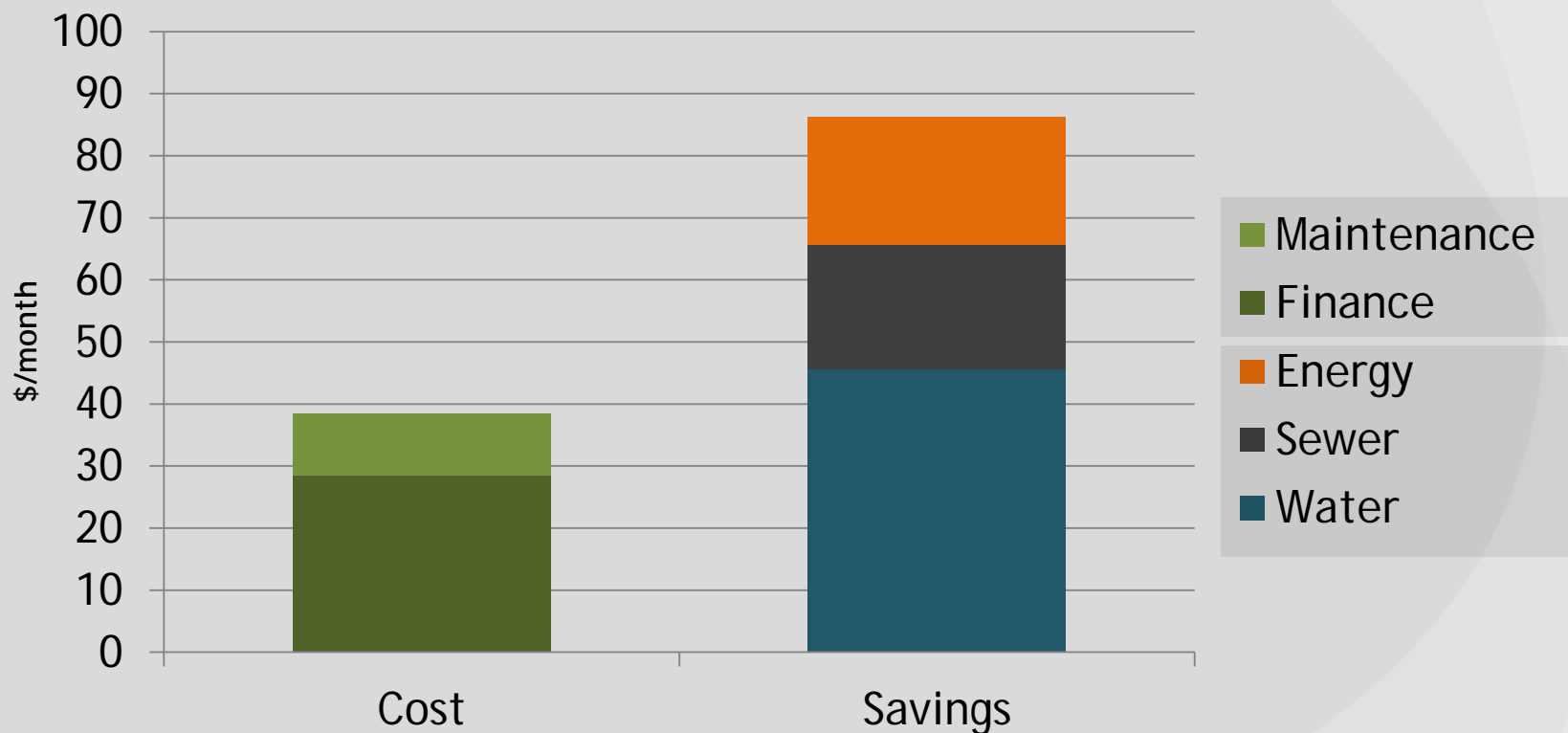


# Kohler's NSF 2012 Chart

	Cost			Clarity		Biology		Chem.
	Equipment	Annual Maintenance	Electrical	Turbidity	TSS	CBOD5	E. Coli	pH
1 - Filtration, Chlorination	\$2,600	\$150	\$0	5.6	10.6	16.4	8.2	7.4
2 - Advanced Oxidation	\$4,500	\$355	\$59	8.3	10.2	13.3	<1.0	7.5
3 - Membrane Bioreactor	\$7,500	\$50+	\$121	0.2	<1.0	<4.3	<1.0	7.8
4 - Biological, Media Filter	\$8,950	\$580	\$98	0.5	<1.2	<2.4	<1.0	7.6
NEXtreater	\$3,995	\$120	\$75	0.5	<1.0	<3.0	<1.0	7.4

# Immediate Payback: Mortgage vs Monthly Costs

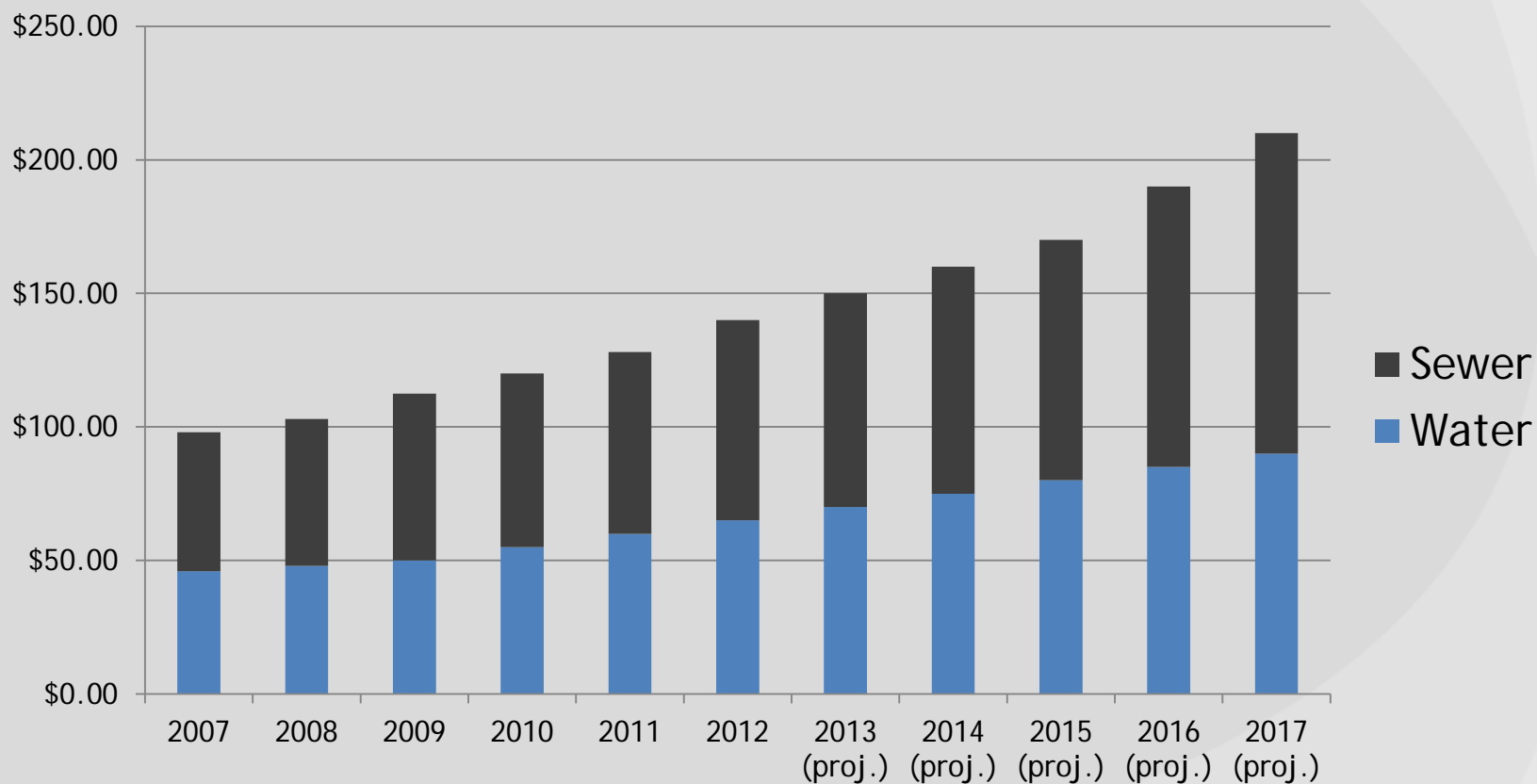
Example: San Diego - Today



# Rising Water and Sewer Rates: You Ain't Seen Nothin' Yet

## Rising Water and Sewer Rates - Pre-Drought

(Source: Black & Veatch - Largest 50 metros)



## HOW DOES THE DOUBLE ZEROHOUSE WORK?

KB Home's Double ZeroHouse 3.0 in El Dorado Hills generates as much energy as it uses. It recycles drain water for toilets and sprinklers and heats fresh water with warmth from gray water.

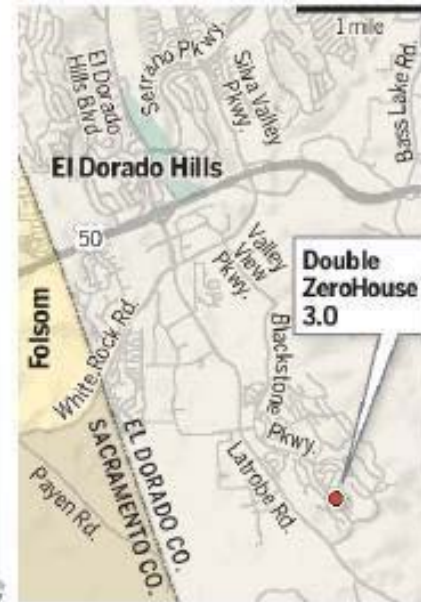
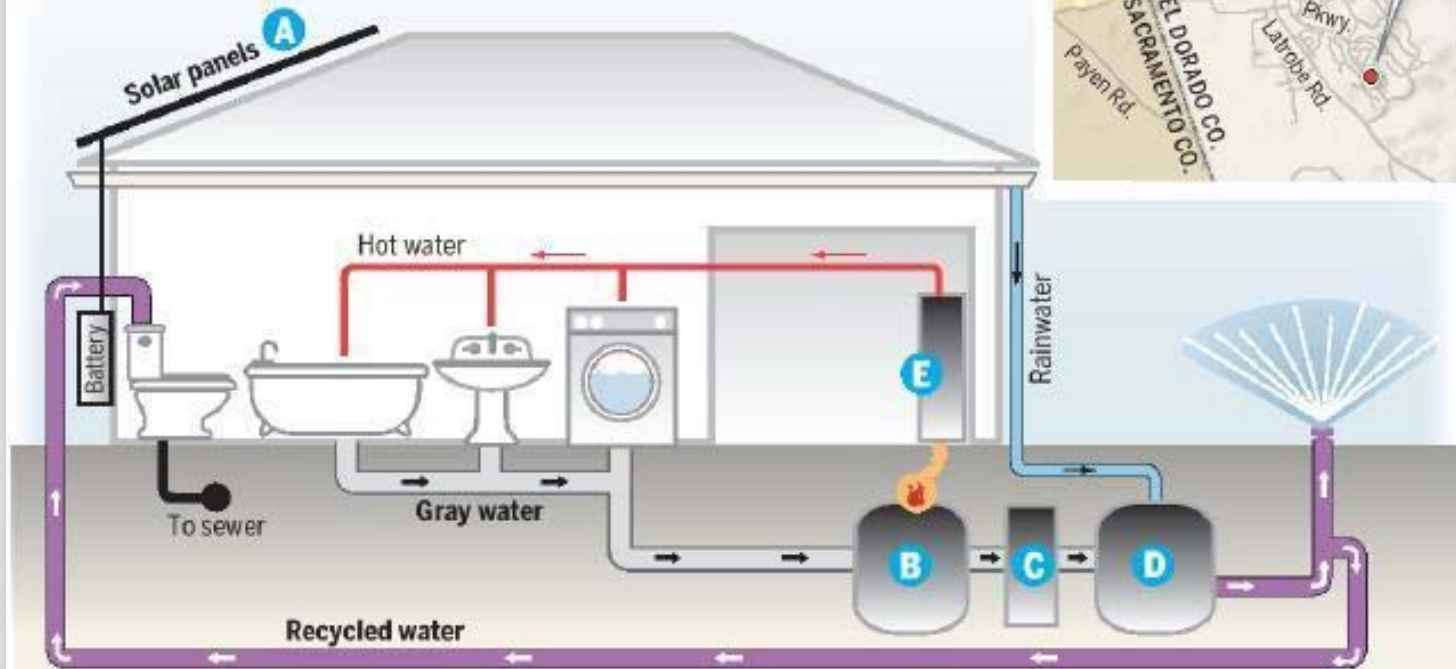
**A** Rooftop solar panels generate enough energy to power the home. Batteries store electricity for use in case the grid fails.

**B C** Drain water from sinks, showers and laundry is collected, filtered and disinfected.

**D** The reclaimed water, along with collected

rainwater, is stored in an underground reservoir, then used to flush toilets and irrigate landscaping.

**E** The system also collects remaining warmth from the drain water and uses it to heat fresh water.



# Issues Integrating Rainwater Into Nexus Recycling System

- Rainwater commingled with Treated Grey Water in cleaned storage and supply system, the NEXservoir
- Rain Water is collected in downspouts, filtered and directed to the NEXservoir storage tank
- Overflows diverted *prior* to entering NEXservoir
- Stored water disinfected regularly (UV)
- CODE ISSUE: Rainwater can *theoretically* overflow into sewer from NEXservoir (but not a practical concern)

# Solution Development Goals - Grey Water + Rain Water Integration

- Eliminate need for separate solutions
- Reduce/eliminate possible cross connection points
- Focus integration on post-filtration storage and supply system
- Maintain *both* waters at standard that permits widest possible use
- Disinfection required



# Next Steps On “Grainwater” Integration

- Technology demonstration – planned for early 2015
- Code revision
- Work with Public Health, Water Resources, and legislators
- Roll out products

## Other benefits:

Water use drops 25-40% below WaterSense homes

But - sewage drops 67%

- Less overloaded pipes
- Less SSO's
- Smaller WWTP's
- Lower energy costs: less pumping and treating

Energy can also be recycled!

- Three out of every 4 watts get 'a second lease on life'

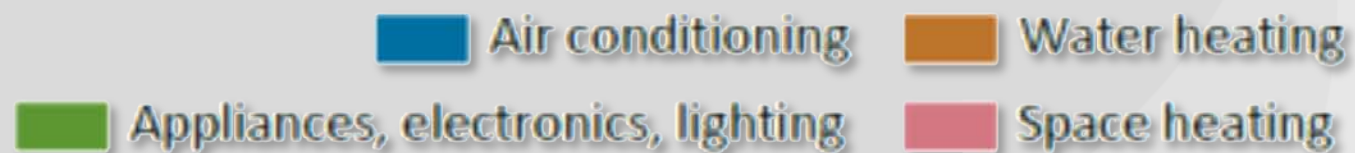
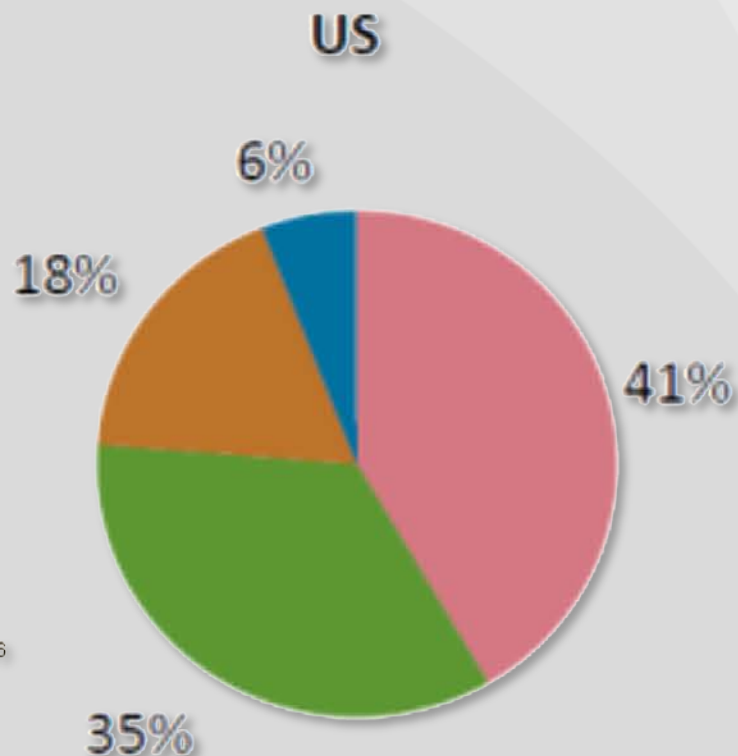
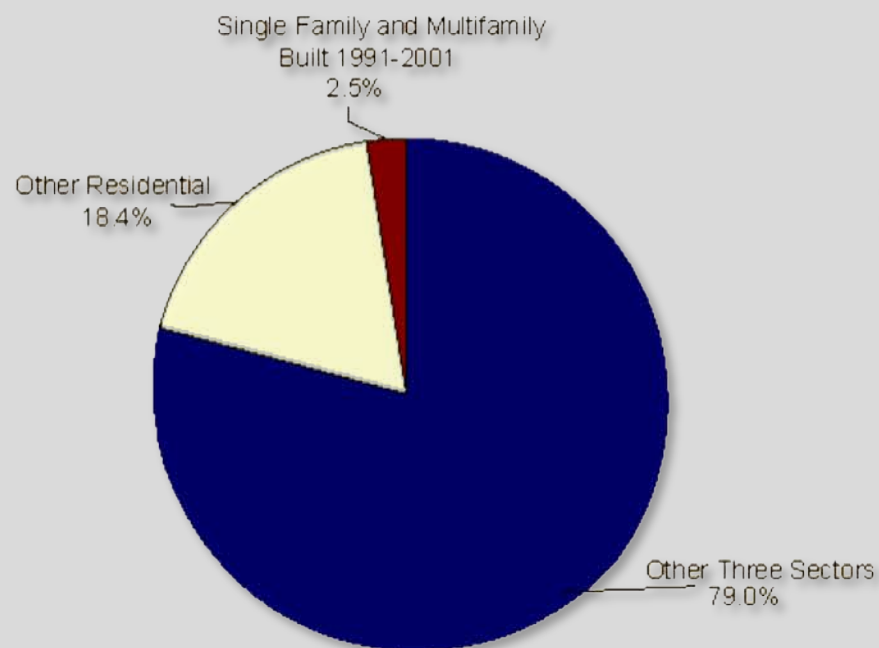
# What is eWater?



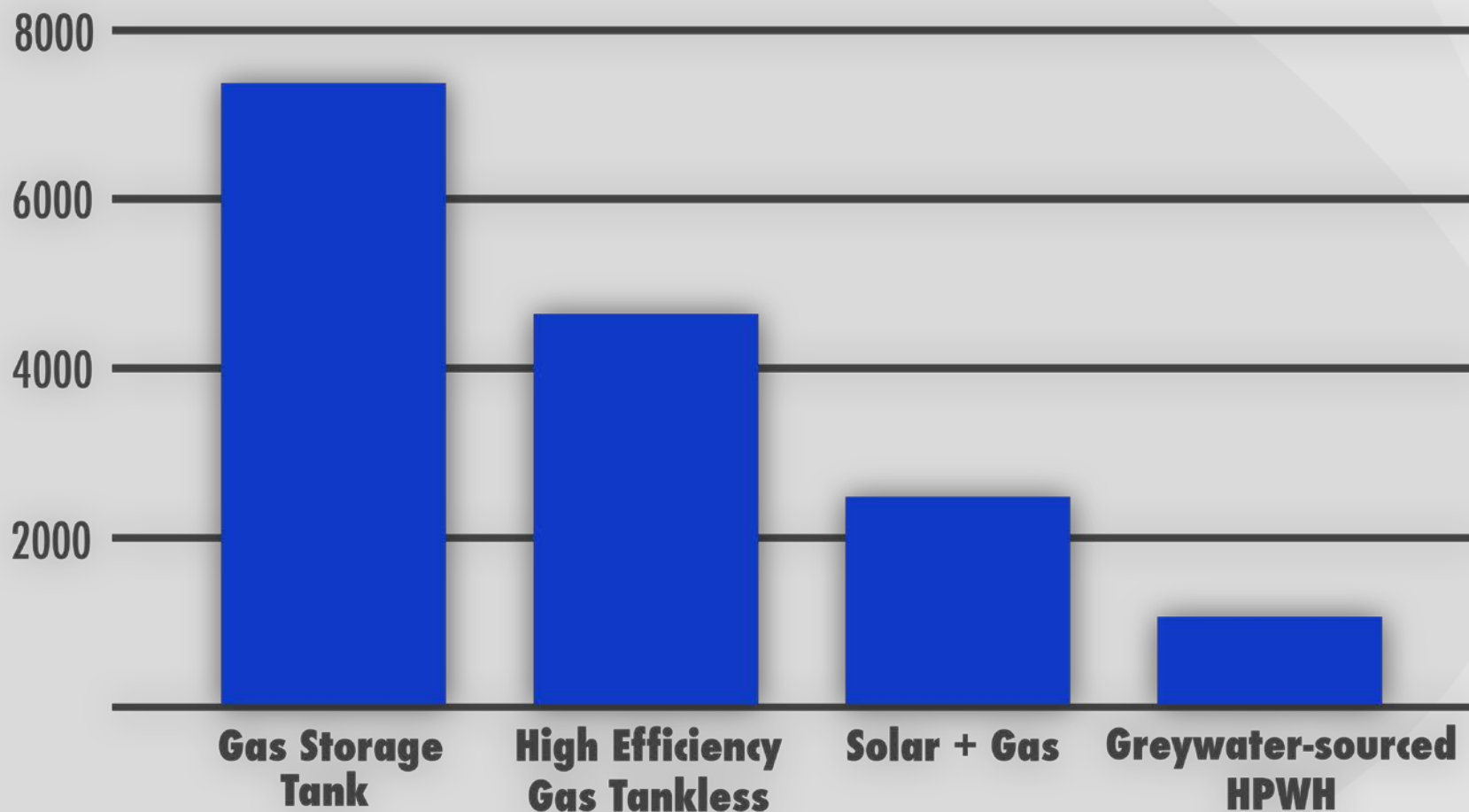
**WATER**

**+**

**ENERGY**



## ANNUAL ENERGY REQUIRED FOR WATER HEATING, $\text{kWh}$



# WWBFD?



*"You may delay - but Time will not!"*

*"Never put off till tomorrow what you can do today"*

*"Especially when your well is running dry!"*

# What Can be Done Today

The Sustainable Energy Community makes homes 'Solar-Ready' (July 1 mandate]

New homes should be 'Recycle-Ready'

- Dual Plumbing in homes
- Recycling Infrastructure
- >1% of new home construction

Start a rebate program for retrofitting homes





# Summary

- Sending centralized recycled wastewater to the home is usually impractical and expensive
- On-site greywater recycling is the most consistent solution, but additional potential remains
- Rainwater is Next Best alternative Water Source
- Technology has caught up with the opportunity
- NRDC 25 x 25 is almost achievable today
- Code and policy ambiguities are the only barriers to market introduction
- 'Recycle-ready' cities can be implemented *today*



# Thank You

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# Future Impact...

<b>Recycling Potential of the Recycle-Ready City</b> <i>Assumes 3 percent annual growth for 20 years</i>		
	<b>The City Today</b>	<b>The City in 20 Years</b>
Population	30,000	58,900
Homes	10,000	18,900
<b>Average water use (gpcd)</b>	<b>154</b>	<b>129</b>