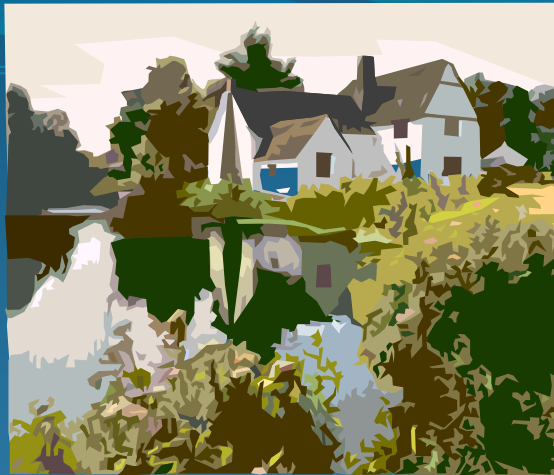This presentation premiered at WaterSmart Innovations

watersmartinnovations.com

Assessing Decreases in Single Family Water Use

Based on Empirical Data from Four Key End Use Studies

By: William DeOreo, P.E.
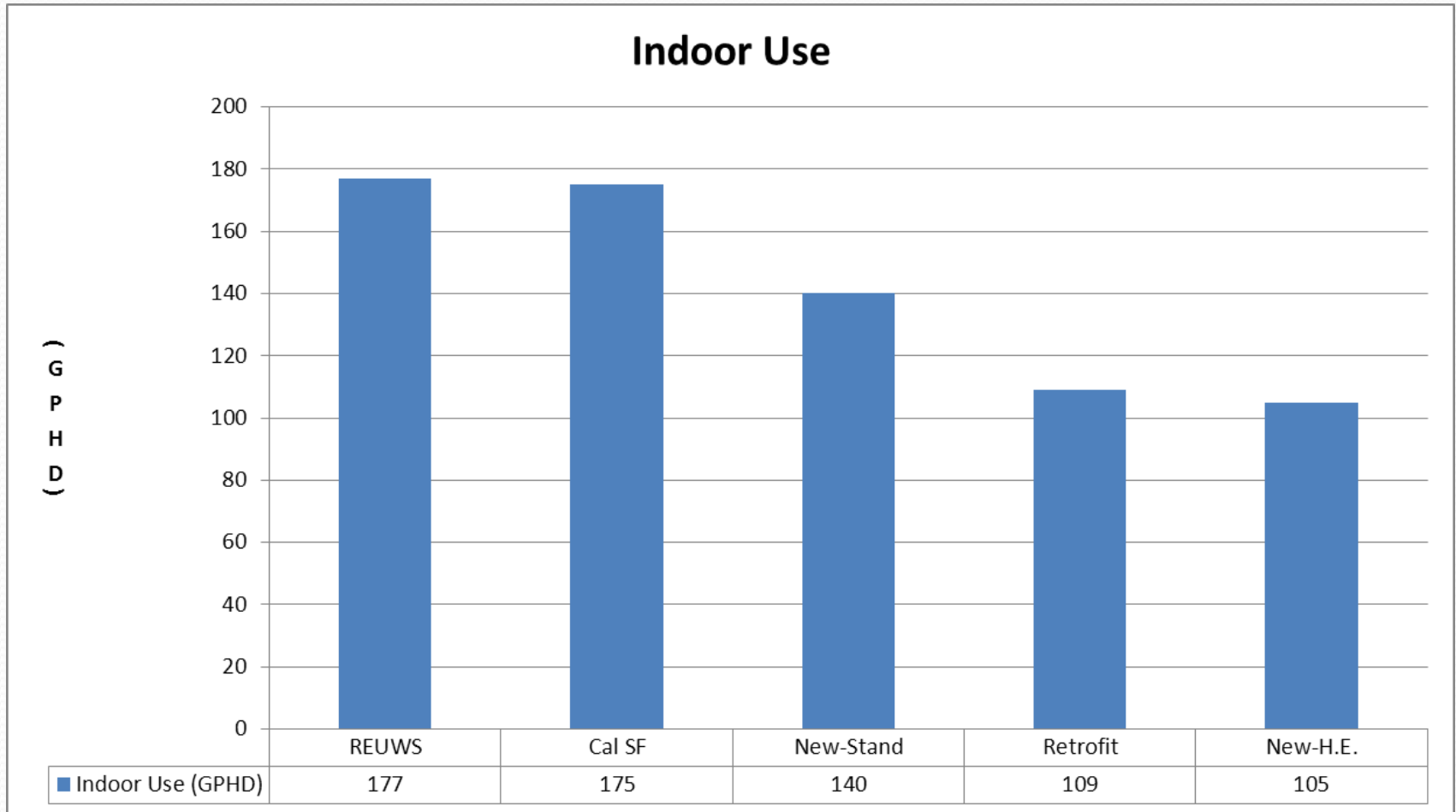
Aquacraft, Inc.

Boulder, CO

Key Findings

- Single family water use is decreasing on both a household and a per-capita basis
- Major reductions seen in toilets and clothes washer use
- Subtle changes occurred in existing homes between 1997 and 2007
- Significant reductions seen in off-the-shelf new homes.
- The best reductions seen in high efficiency homes (retrofit homes and high efficiency new homes)
- This trend should continue into the future and should be used for future planning studies.
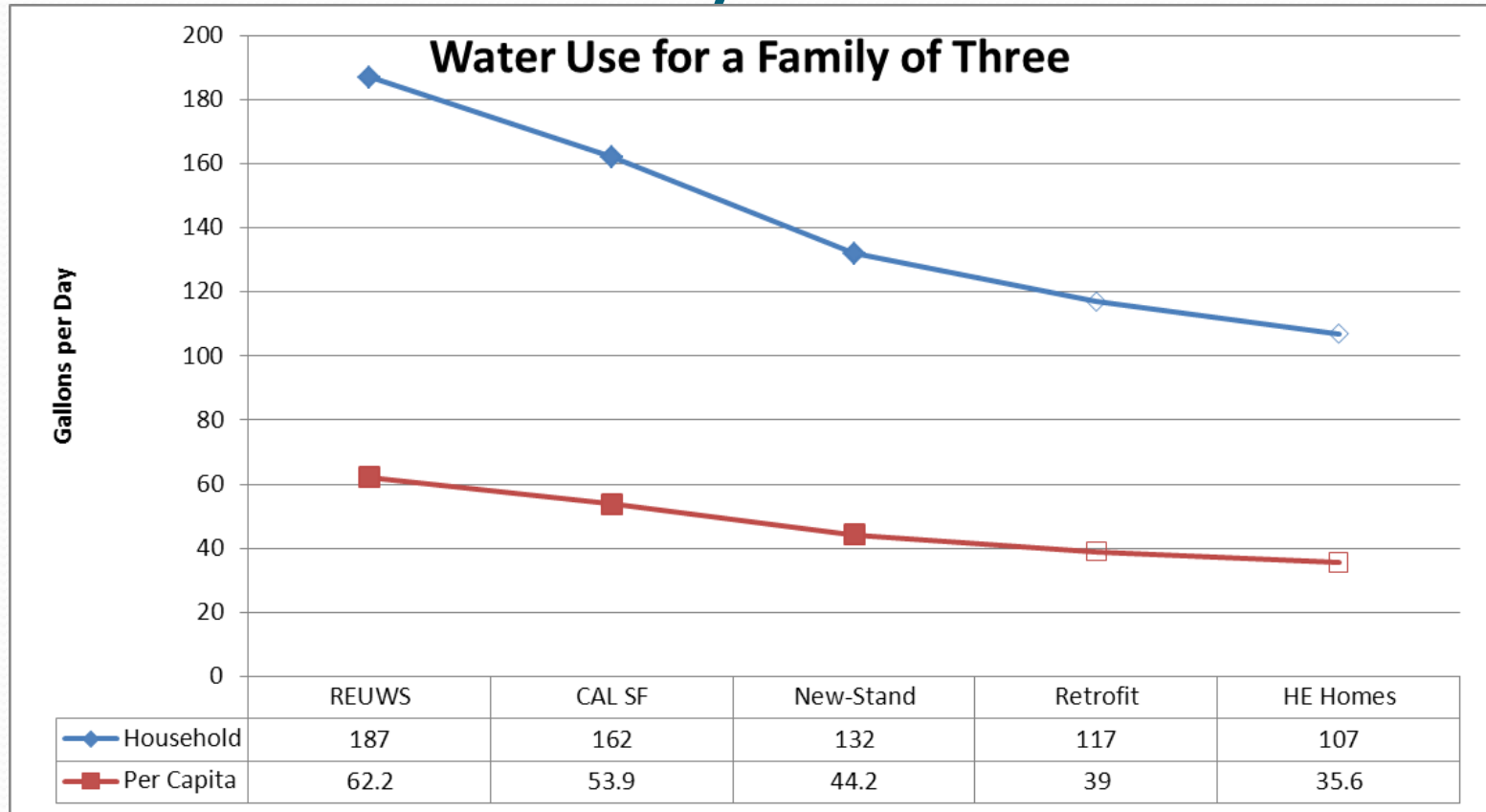- Outdoor Use has been stable
  - (Pre Recession)

Four Studies, Five Groups

- REUWS (1997) provides the baseline for existing homse (year 0)
- California SF Study (2007) provides a reference for existing homes (10 years after REUWS)
- EPA New Home Study provides two groups
  - Standard new homes, built in 2001, sampled in 2007
  - High efficiency new homes, built around 2006, designed for maximum water use efficiency
- EPA Retrofit Study provides sample of existing homes brought up to high efficiency standards through retrofits

Household Use is Declining

Indoor Use

Indoor Use (GPHD)	REUWS	Cal SF	New-Stand	Retrofit	New-H.E.
	177	175	140	109	105

Per Capita Use is Declining (normalized data)

Water Use for a Family of Three

	REUWS	CAL SF	New-Stand	Retrofit	HE Homes
Household	187	162	132	117	107
Per Capita	62.2	53.9	44.2	39	35.6

Gallons per Day

Biggest Declines in Toilets & CW's

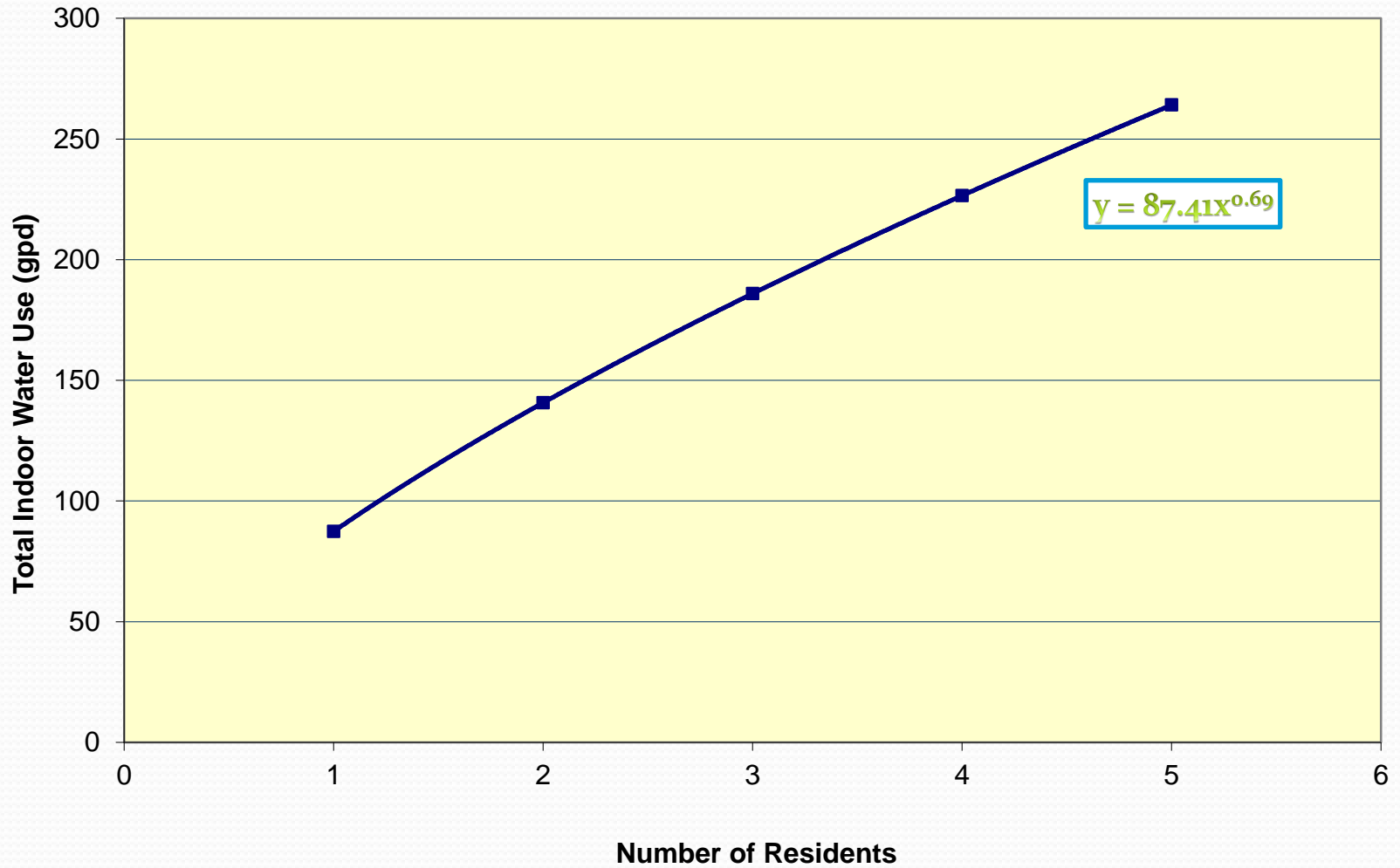|	Toilet gpd	Clotheswasher gpd	Shower gpd	Faucet gpd	Leak gpd	Other gpd	Bathtub gpd	Dishwasher gpd
■ REUWS	45.2	39.3	30.8	26.7	21.9	7.4	3.2	2.4
■ Cal SF	37.3	30.6	34.3	32.6	30.7	3.6	3.7	1.5
■ New-Stnd	27.5	28.9	29.9	25.2	19.7	3.0	3.5	1.9
■ Retrofit	20.3	23.3	23.9	20.1	11.2	1.5	7.0	2.1
■ New-HE	16.2	11.9	34.3	18.1	19.2	0.4	3.1	1.6
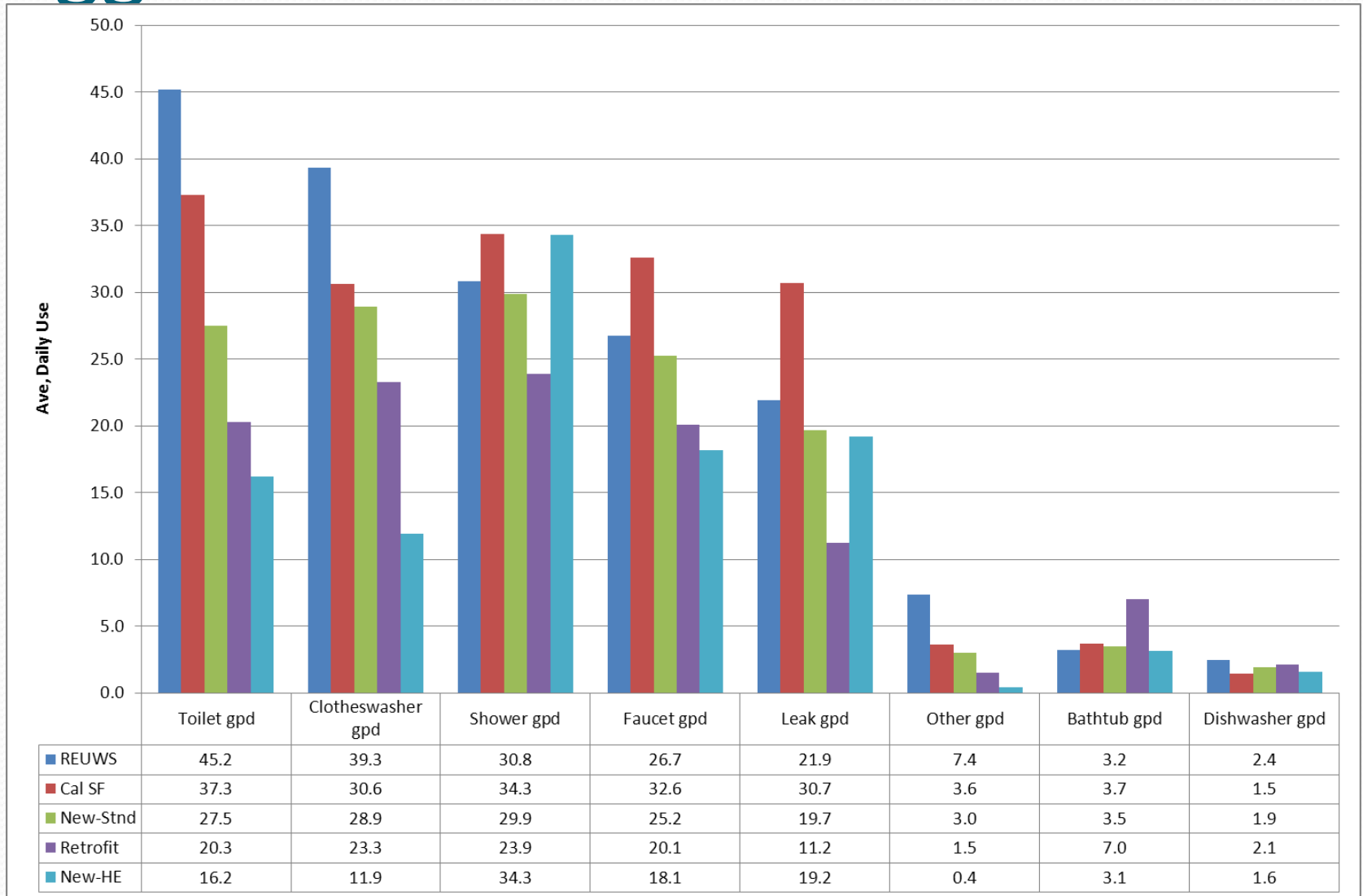
Non-linear nature of demand

- Water demands increase with residents following a power curve relationship:

$$Y = c\ R^{x<1}$$
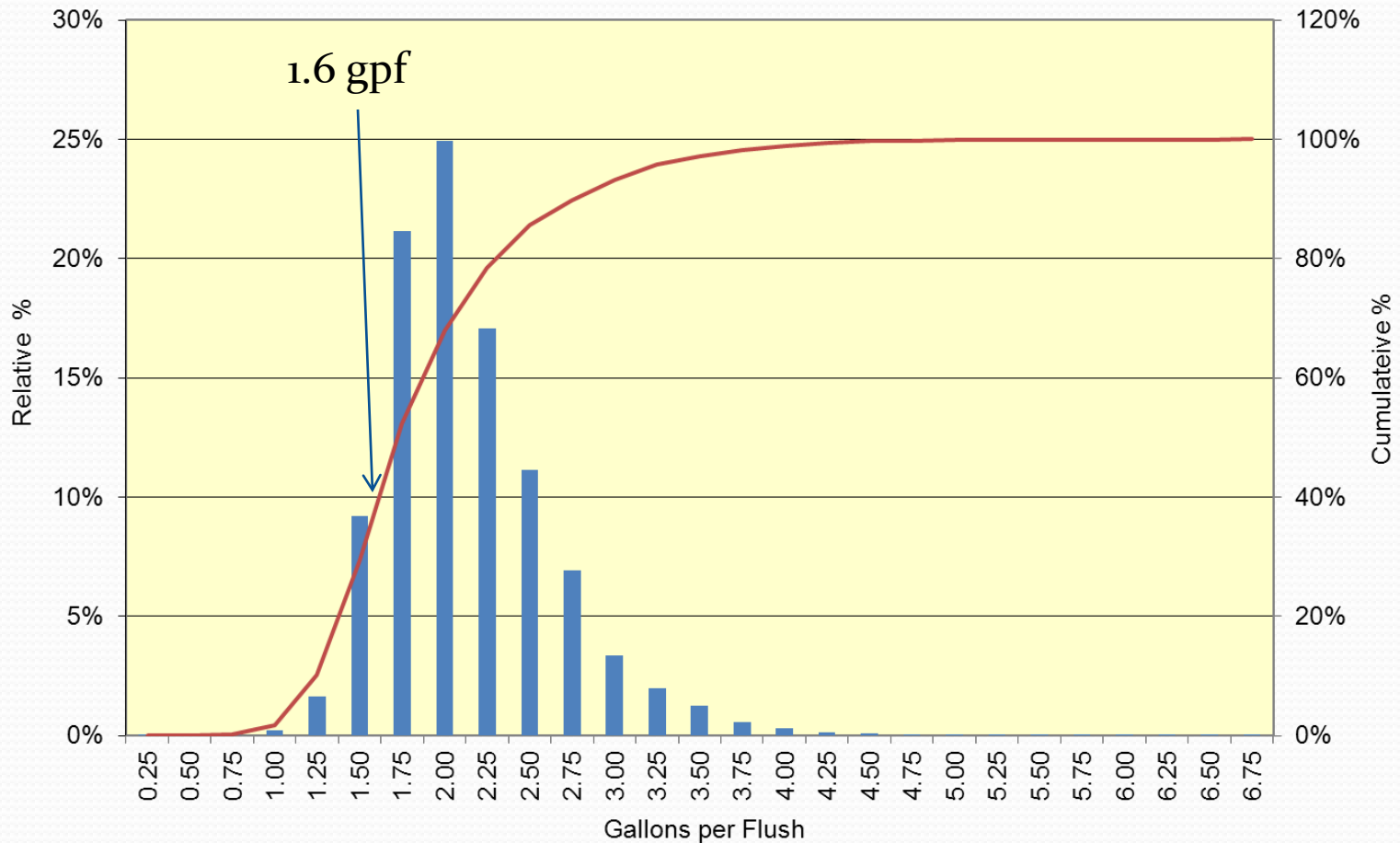
Per-capita Use is Non-Linear
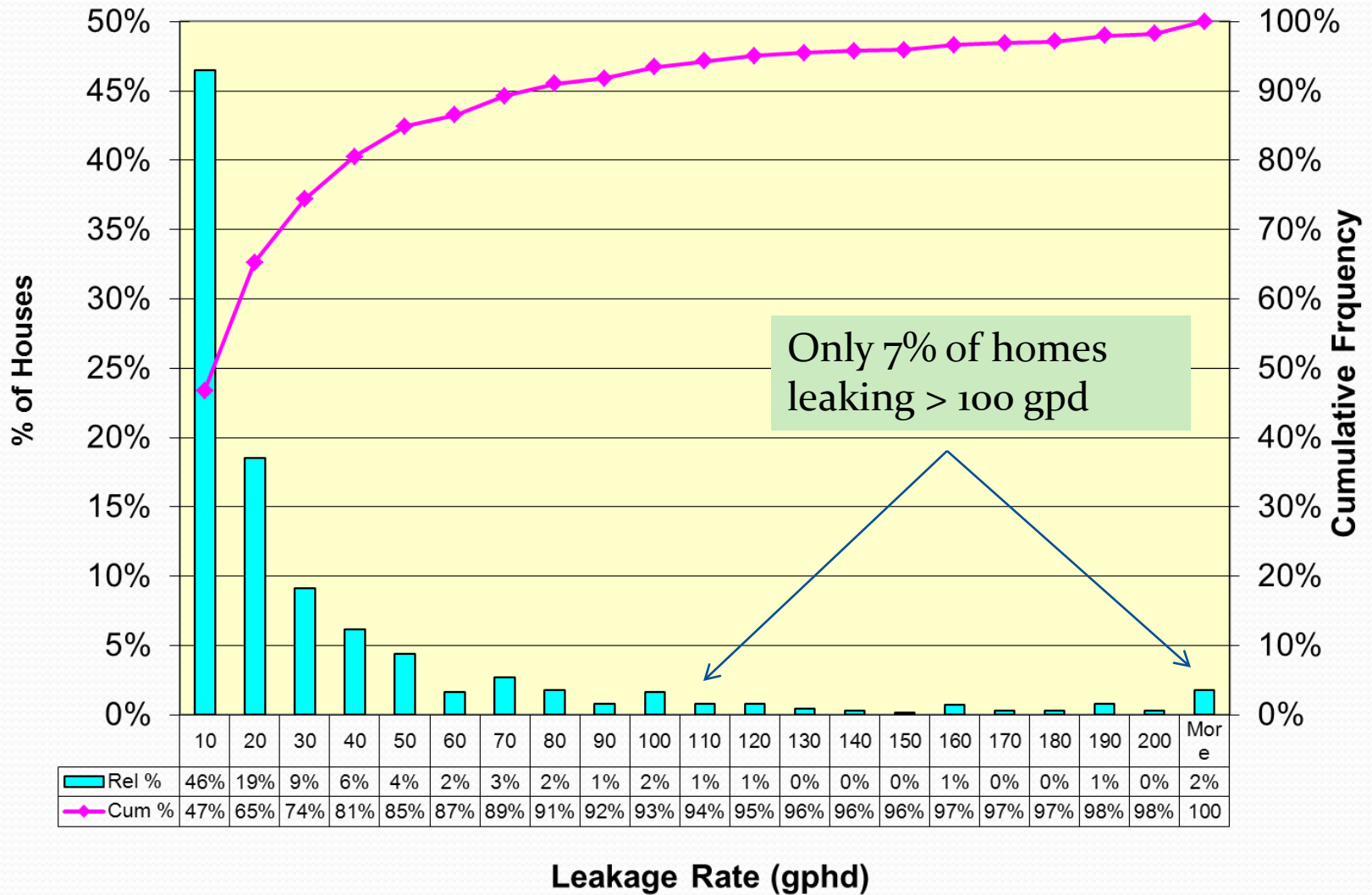

$y = 87.41x^{0.69}$

Total Indoor Water Use (gpd)

Number of Residents

Linear approach can lead to big errors

$y = 87.406x$

$y = 87.41x^{0.69}$

Total Indoor Water Use (gpd)

Number of Residents

Declining Flush Volumes

	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75
REUWS	0%	0%	0%	0%	1%	3%	5%	5%	4%	4%	5%	6%	7%	8%	8%	8%	8%	6%	5%	4%	3%	3%	2%	1%	1%	1%	3%
Std NEW	0%	0%	0%	0%	2%	9%	21%	25%	17%	11%	7%	3%	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HE New	0	2%	14%	13%	27%	25%	11%	5%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Gallons per Flush
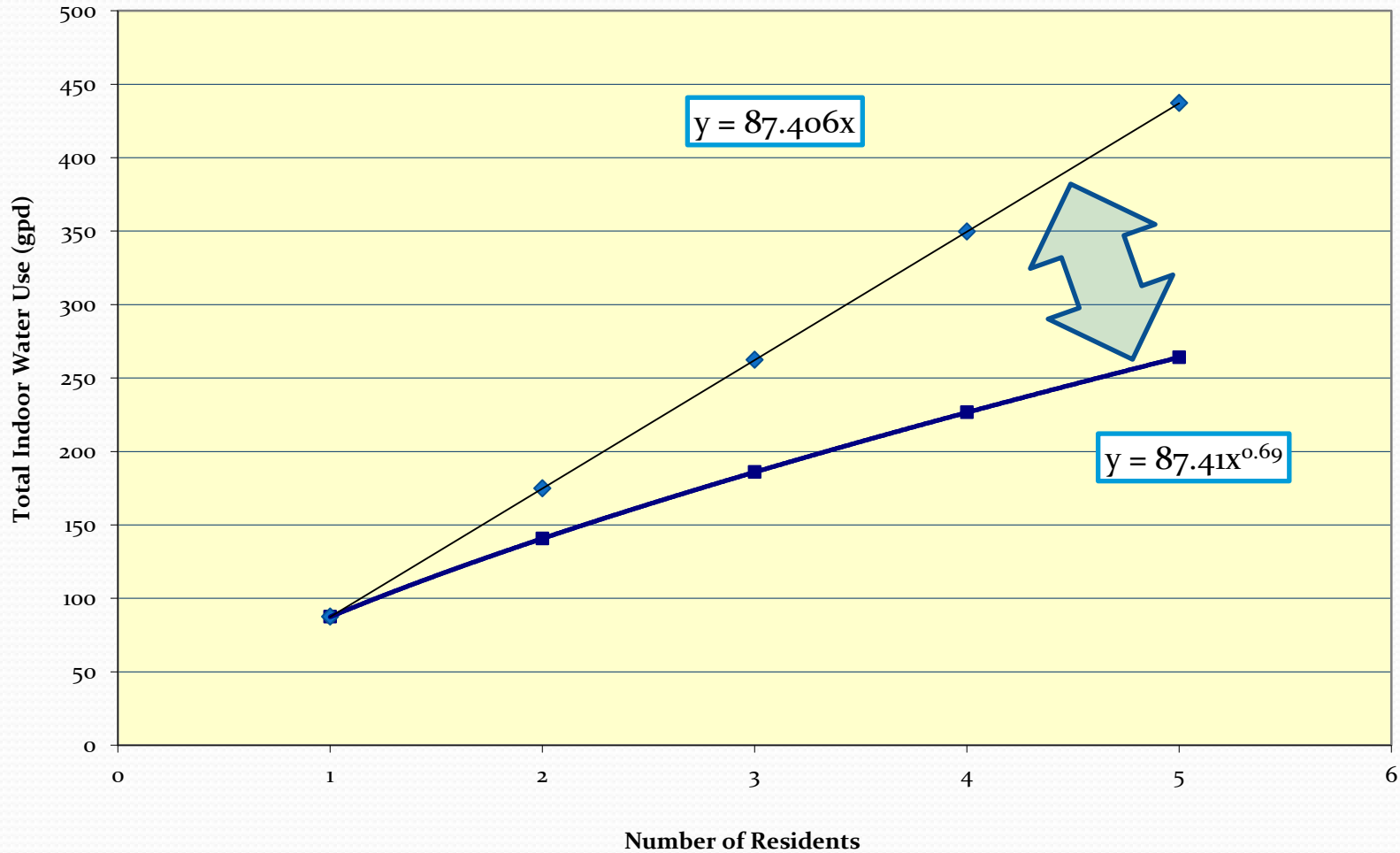
Unexpected Toilet Volume Distribution

Distribution of Flush Volumes in New Homes

Leaks are Skewed

Only 7% of homes leaking > 100 gpd

Leakage Rate (gphd)

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	More
Rel %	46%	19%	9%	6%	4%	2%	3%	2%	1%	2%	1%	1%	0%	0%	0%	1%	0%	0%	1%	0%	2%
Cum %	47%	65%	74%	81%	85%	87%	89%	91%	92%	93%	94%	95%	96%	96%	96%	97%	97%	97%	98%	98%	100

Leakage by % of Volume
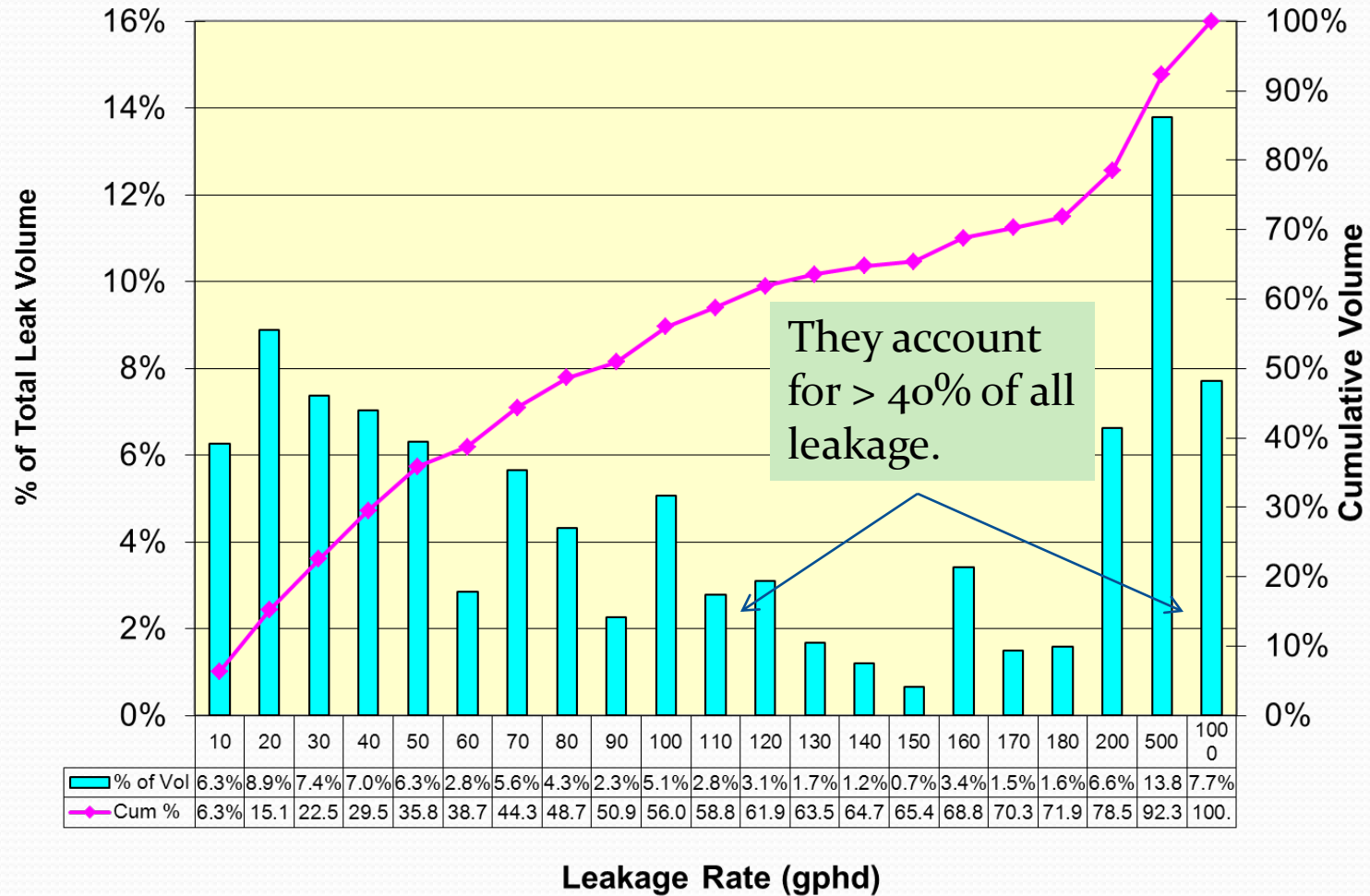
Increasing Percentage of Efficient Homes

% of Homes meeting toilet and CW efficiency criteria

|	REUWS	CAL-SF	New-Stnd	H.E. Homes
Toilet	10	30	48	96
CW	3	30	39	100
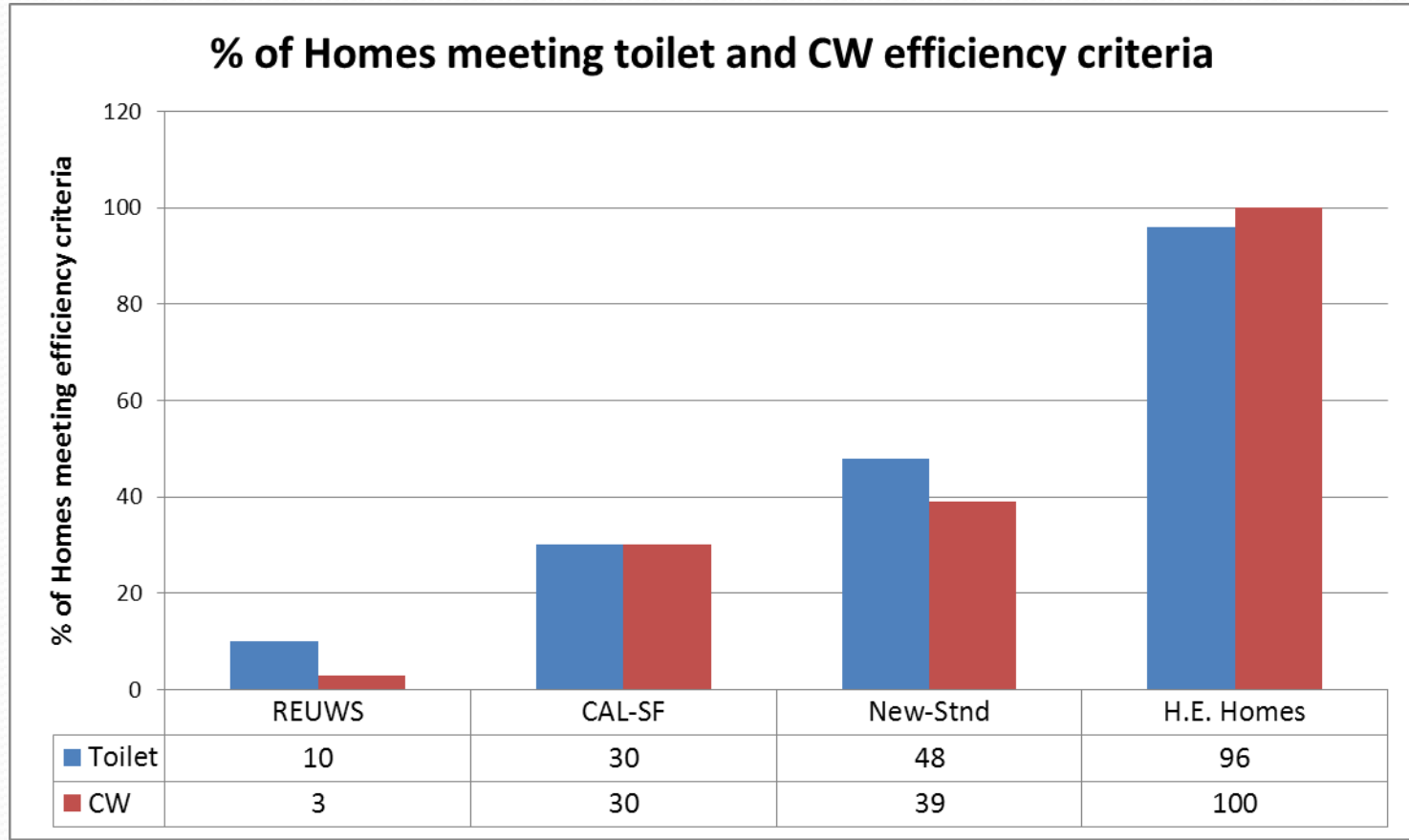
Determining Per Capita Usage

Parameter	REUWS (built before 1995)	California Single Family	Standard New Homes (built since 2001)	EPA post-retrofit group	High-efficiency New Homes
Mean (gphd)	177	186	140	107	105
Per capita relationship (gphd=)	$87.41x^{0.69}$	$72.67x^{0.73}$	$66.30x^{0.63}$	$50.21x^{0.77}$	$59.58x^{0.53}$
Household use for family of 3 (gphd)	187	162	132	117	107
Projected per capita use for family of 3 (gpcd)	62	54	44	39	36

Grouping Houses by Efficiency

Comparisons of Household Use vs Residents
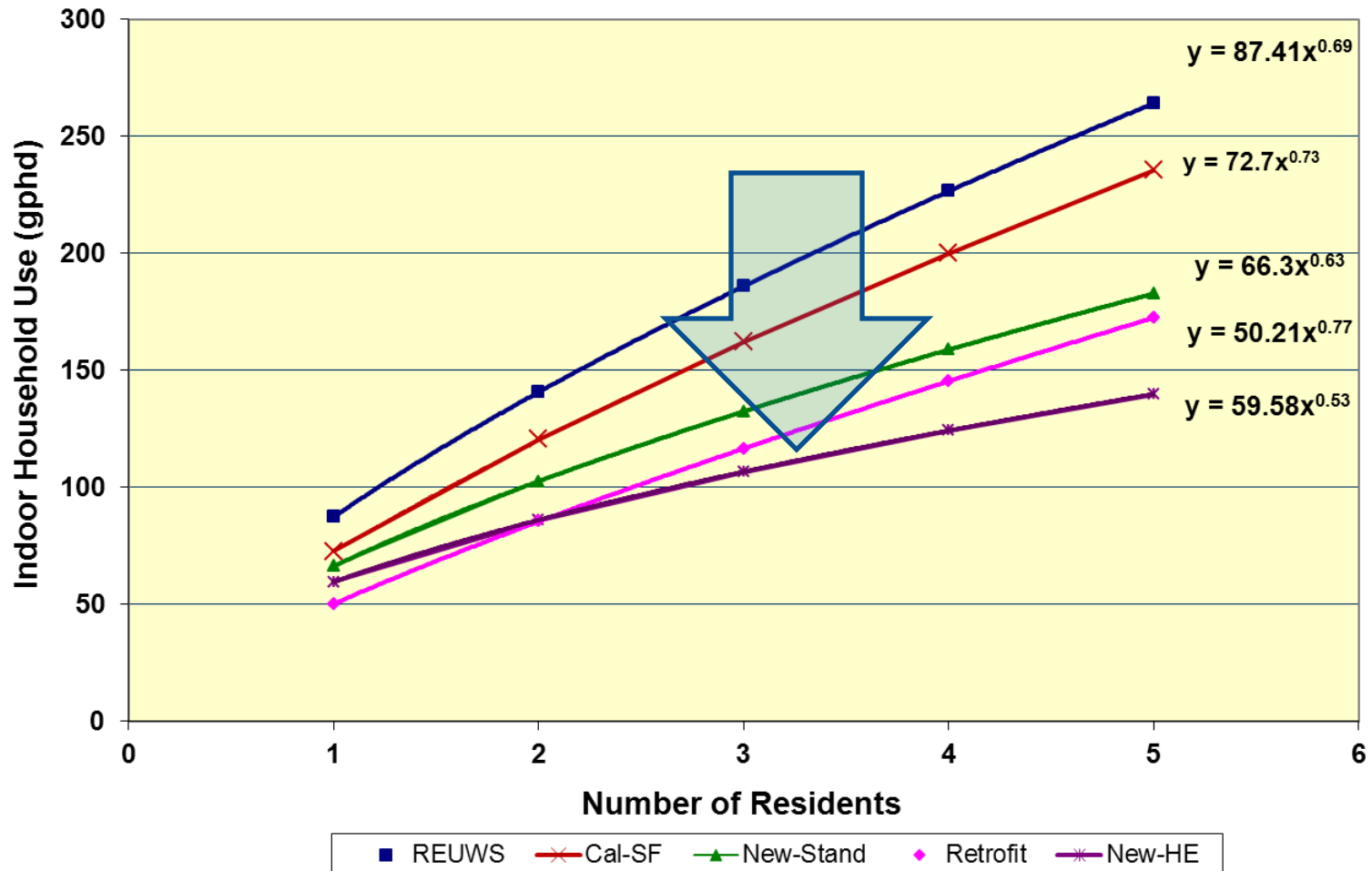
Factors that Affect Indoor Use

- Number of residents (+)
- Presence of Leaks (100 gpd) (+)
- Presence of High efficiency toilets and clothes washers (-)
- Presence of child or youth (-)
- Presence of garbage disposals and dishwashers (-)

Outdoor Parameters (Look Similar)

- Existing Homes (Cal SF)
  - Lot Size ~9200 sf
  - Irrigated Area ~3400 sf
  - Outdoor Use ~93 kgal
  - Application ~57 in
  - ETo ~ 42 in
  - App Ratio ~1.36
  - Ave Excess ~ 29.4 kgal
  - Var from ET ~6.5 kgal

- New Homes (EPA)
  - 10,100 sf
  - 3700 sf
  - 78 kgal
  - 56 in
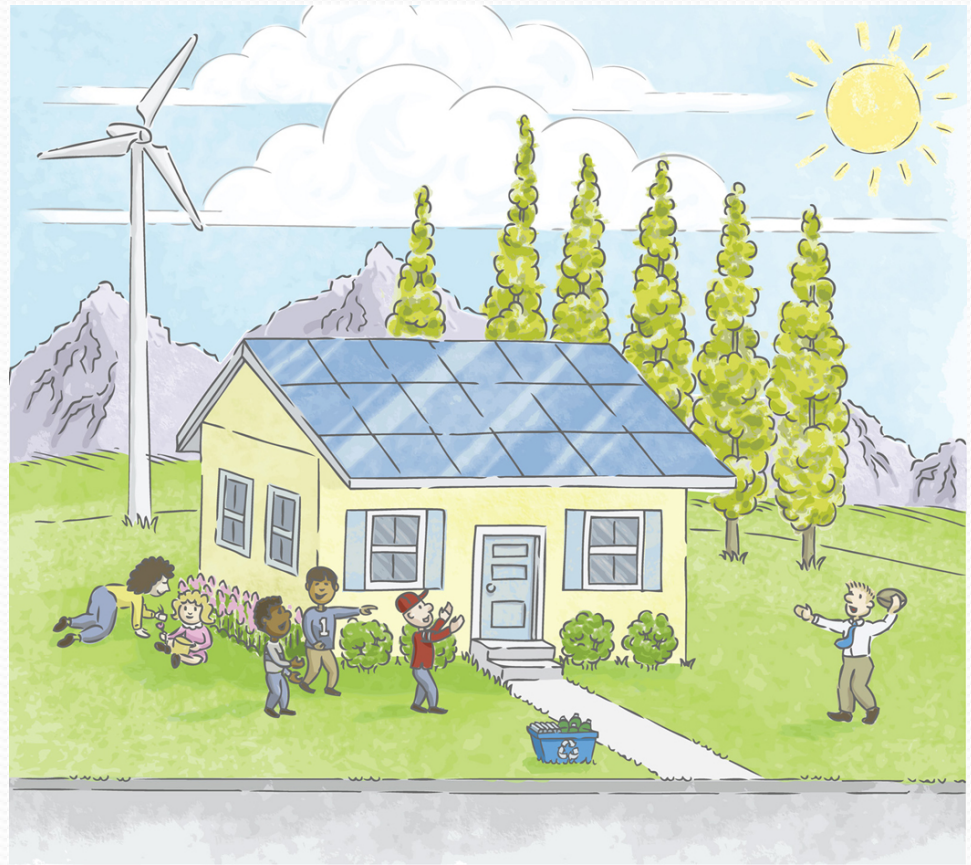 - 43 in
  - 1.30
  - 30 kgal
  - 7.3 kgal

Factors that Affect Outdoor Use

- Net ET (in)
- Irrigated Area (SF)
- Income ($)
- Landscape Ratio (TIR/Ref Requirement)
- Pool (?)
- **Excess Irrigation** (?)
- Sprinkler (?)

Something you can plan on.

- Planners have to include new demands in water supply models.
- Capitalize on benefits of conservation efforts.
- Avoid costly over-building.

Recommendations

- Look beyond your billing data
- Create better tracking tools
- Get to know your customers better
- Do some sampling and measurements
- Develop demand models from local data
- Use this information for demand projections
- Follow-up with periodic updates for evaluation

Thank you.

- Please visit www.aquacraft.com for copies of these slides and other water demand analyses reports