Dynamic Simulation Modeling of Outdoor Demand:

Key factors, trends, and triggers

Gary Woodard, JD MPP
Water Policy and Economics
Montgomery & Associates

Urban Water Demand Roundtable
Residence Inn Downtown Tempe
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Water providers & regulators supporting this work:

- Tucson Water
- Central Arizona Project
- Bureau of Reclamation
- AZ Dept. of Water Resources
- SAWUA
- Metro Water
- Comm. Water - Green Valley
- Pima County Wastewater

Additional work for litigation support on new construction in Clark County

- Salt River Project
- Central Arizona Project
- Bureau of Reclamation
- AZ Dept. of Water Resources
- Chandler
- Gilbert
- Glendale
- Mesa
- Peoria
- Scottsdale
- Tempe

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Some major questions & concerns

- How low could it go?
- Are some recession-caused drops in demand permanent?
- What will new housing look like in 3-5 years?
- Why the sharp drop in pools?
- Is turf dead?
- Is demand becoming more seasonal?
- How to adjust rate-making?
- How to distinguish active & passive conservation?

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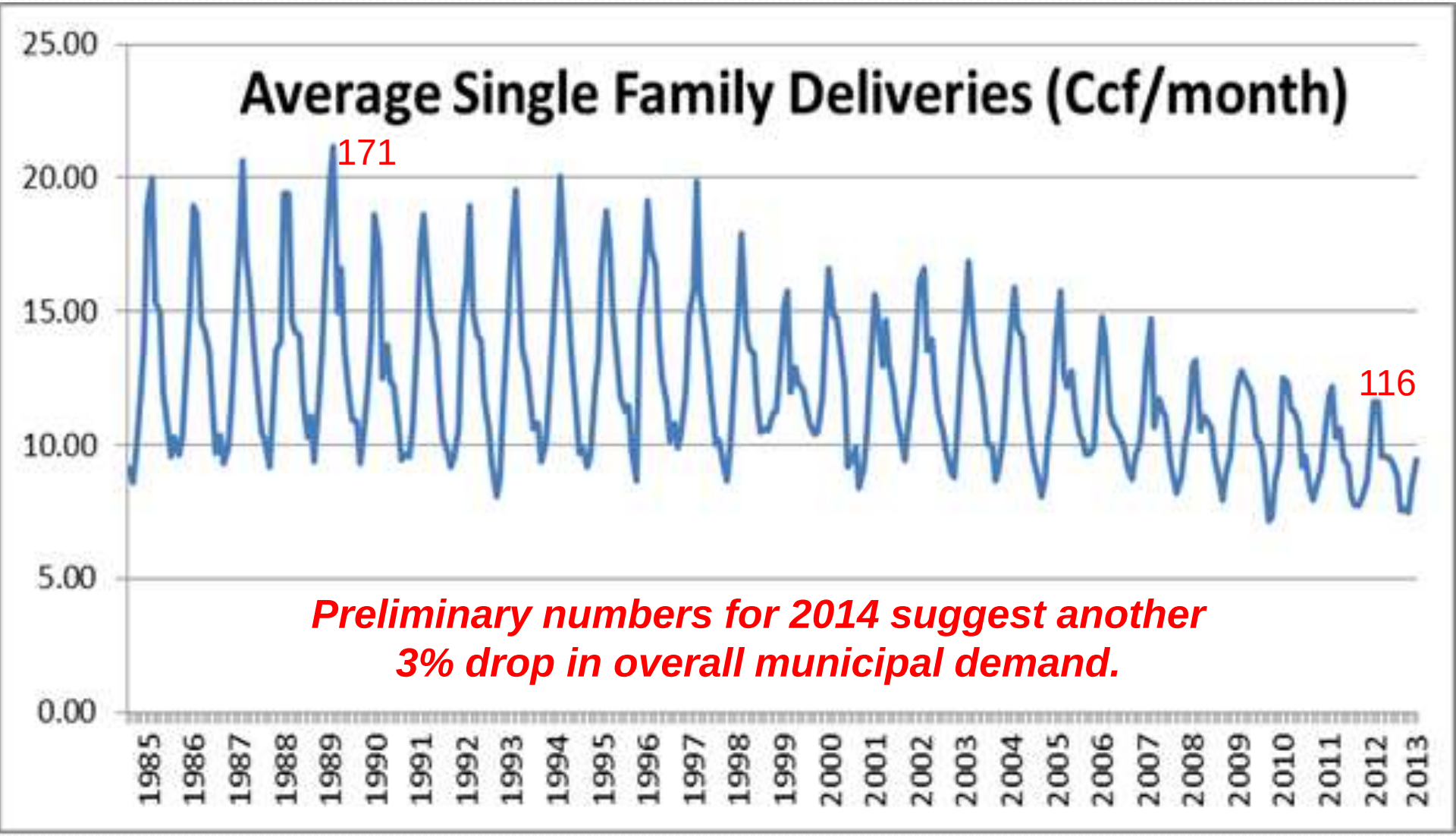
Tucson, Arizona



Preliminary numbers for 2014 suggest another 3% drop in overall municipal demand.

Demand Trends, Pima & Maricopa County

Table 1. Annual Percent Change in SFR Water Demand, 2000-2013				
	Component of Per-Household Demand			
	Total	Indoor	Outdoor	Peak Outdoor
MARICOPA COUNTY	-2.12	-2.02	-2.33	-2.90
PIMA COUNTY PROVIDERS				
COMMUNITY WATER (Green Valley)	-2.0	-1.5	-3.2	-3.6
METRO WATER	-2.2	-2.0	-2.8	-2.5
TUCSON WATER	-2.3	-1.5	-5.0	-5.1
PIMA COUNTY (weighted average)	-2.29	-1.53	-4.80	-4.88

Factors affecting municipal water demand:

Economics
- Water & sewer rates
- Income levels

Changing Tastes
- Pools
- Landscapes
- New homes

Environment
- Persistent drought
- Climate change
- Urban heat island

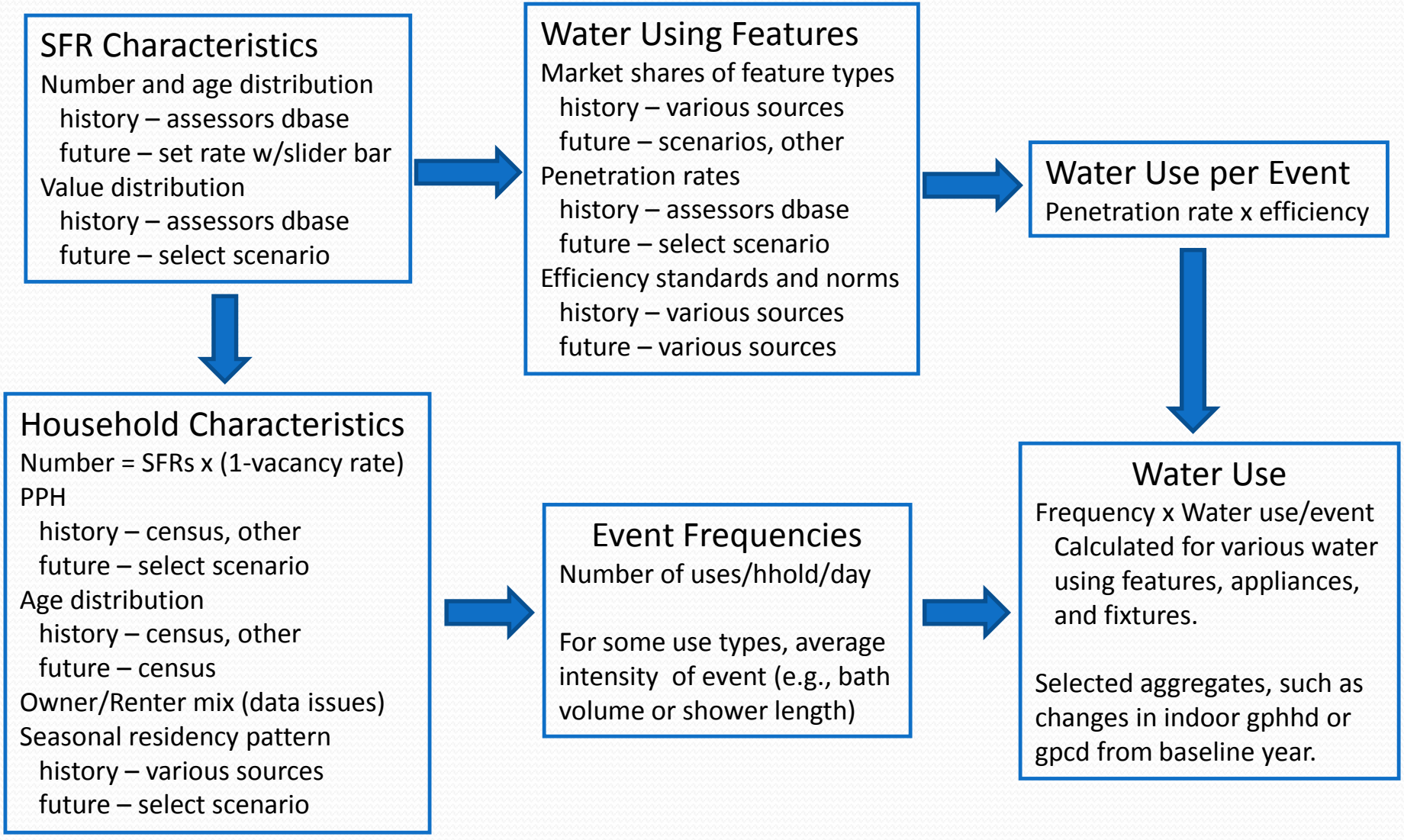
Conservation
- Education & preachments
- Rebates & give-aways
- Demonstration sites

Changing Socio-demographics
- Composition of households
- Seasonal residents

Efficiency Standards
- Federal mandatory
- Federal voluntary
- Neighboring state effects

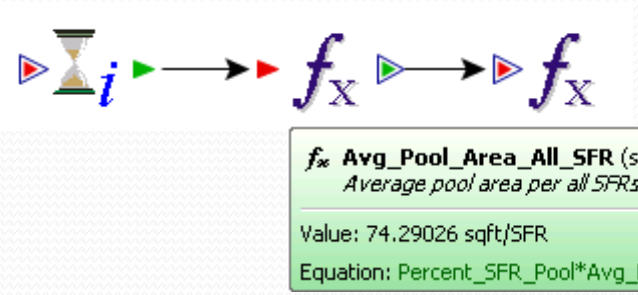
New Technology
- Smart meters
- Next generation washers
- Smart irrigation controllers

Model Structure for Residential Demand Trends



Why a dynamic simulation model?

- **Integrates significant SFR water demand**
- **Addresses uncertainty**
- **Compares scenarios**
- **User interface**
- **Transparent**
- **Graphical outputs**

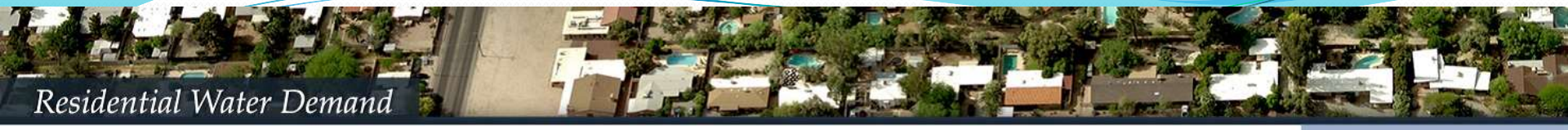


Users can ask “What if?” questions and define a scenario

Adjustable factors include:

- Housing markets
- Socio-demographcs
- Device water use efficiency
- Mandates and rebates
- Increase in water-conscious consumers

Users can also select a pre-defined scenario



EDIT INPUTS & RUN MODEL

DOCUMENTATION

EDIT INPUTS & RUN MODEL

VIEW RESULTS

- Summary
- Demographics
- Indoor Uses
- Outdoor Uses

Before you can edit inputs, the model must be in edit mode, with **Live Model** selected in the Scenarios dropdown in the box to the right.

- To activate edit mode, press **F4**. To activate results mode, click Run.
- To save a scenario for future use, click +.
- To run the model using a preset or saved scenario, select an option from the Scenarios dropdown and click Run.

SCENARIOS
Run Model & Select / Save Scenarios
Live Model | Run | + | -

Reset Inputs to Baseline

DEMOGRAPHICS

Annual birth rate, %
1 — 1.27 — 1.4

Annual growth rate of new SFRs, %
0 — 1.2 — 4

Annual sales rate of existing SFRs, %
0 — 6.5 — 12

Houses flipped, % existing homes
0 — 0.25 — 2

INDOOR USES

Clothes washer efficiency, gals/load
Current

Start date, 2-gpm shower head mandate
2016

Year dual-flush toilet rebate began
Never

OUTDOOR USES

Annual backyard turf removal rate, %
0 — 4 — 8

Annual pool removal rate per year, %
0 — 0.15 — 0.3

Evaporative cooler consumption, gpd
20 — 30 — 40

SAWUA
TUCSON WATER
CAP CENTRAL ARIZONA PROJECT YOUR WATER. YOUR FUTURE.
U.S. Department of the Interior Bureau of Reclamation
Arizona Department of Water Resources
Metro Water District
Pima County Regional Wastewater Reclamation Department

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Dynamic simulation allows models to incorporate deep and complex linkages

Selecting an economic scenario changes

the rate of housing construction

and the distribution of new homes by value

which affect percent of new homes with pools

and the average size of pools

both of which affect outdoor water demand

New SFRs also have larger households with more pre-adults

which changes overall household socio-demographics, and

frequency of use of appliances & fixtures

which affects all facets of indoor demand

And more linkages…

Selecting an economic scenario also changes

the rate of sales of existing houses

and the distribution of existing home sales by value

which affect home remodeling

which affects indoor water demand

Sales of existing SFRs also trigger conversion of swamp to AC

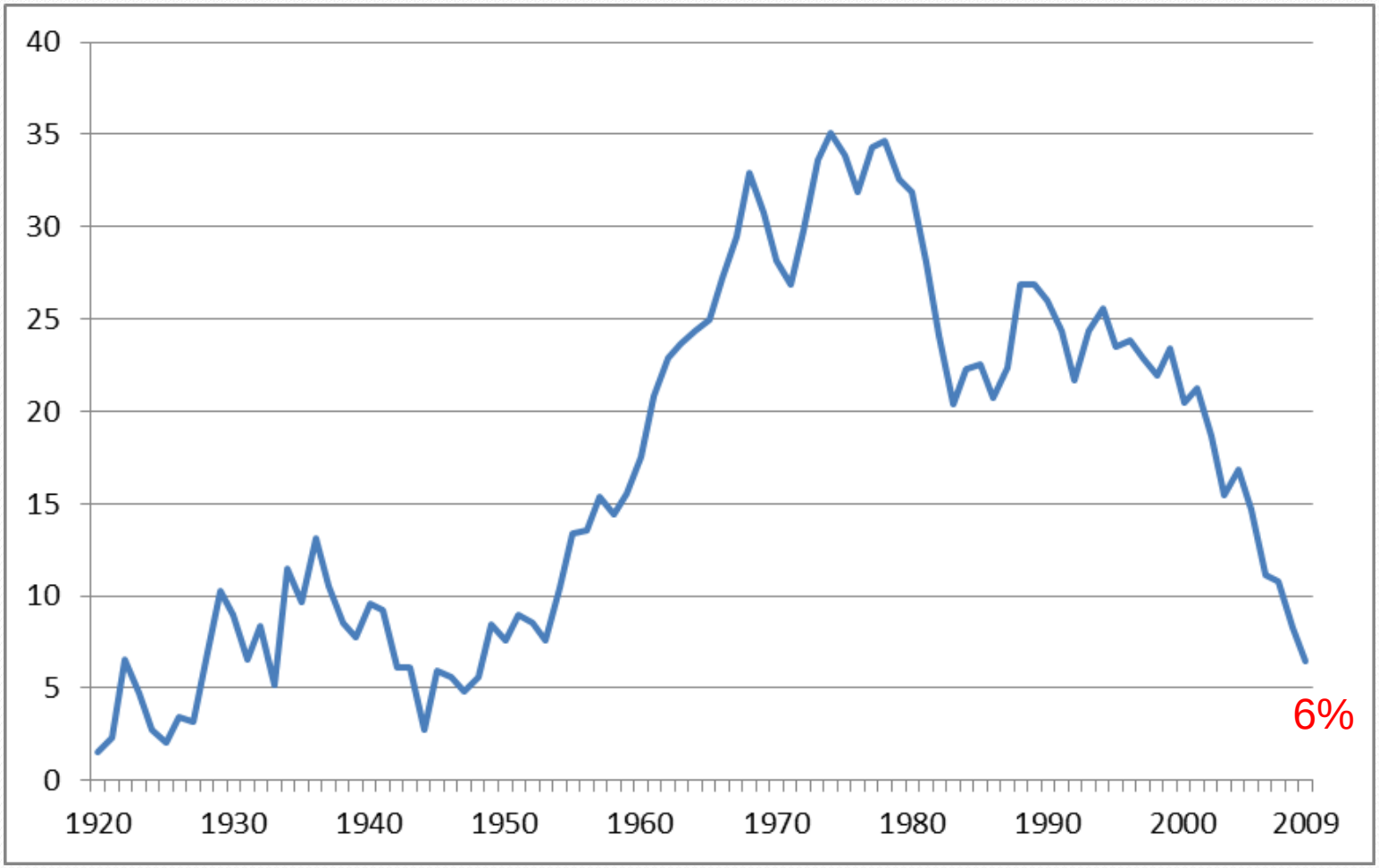
which affects outdoor demand

Everything affects everything, and this model captures that.

Possible factors of long-term decline:

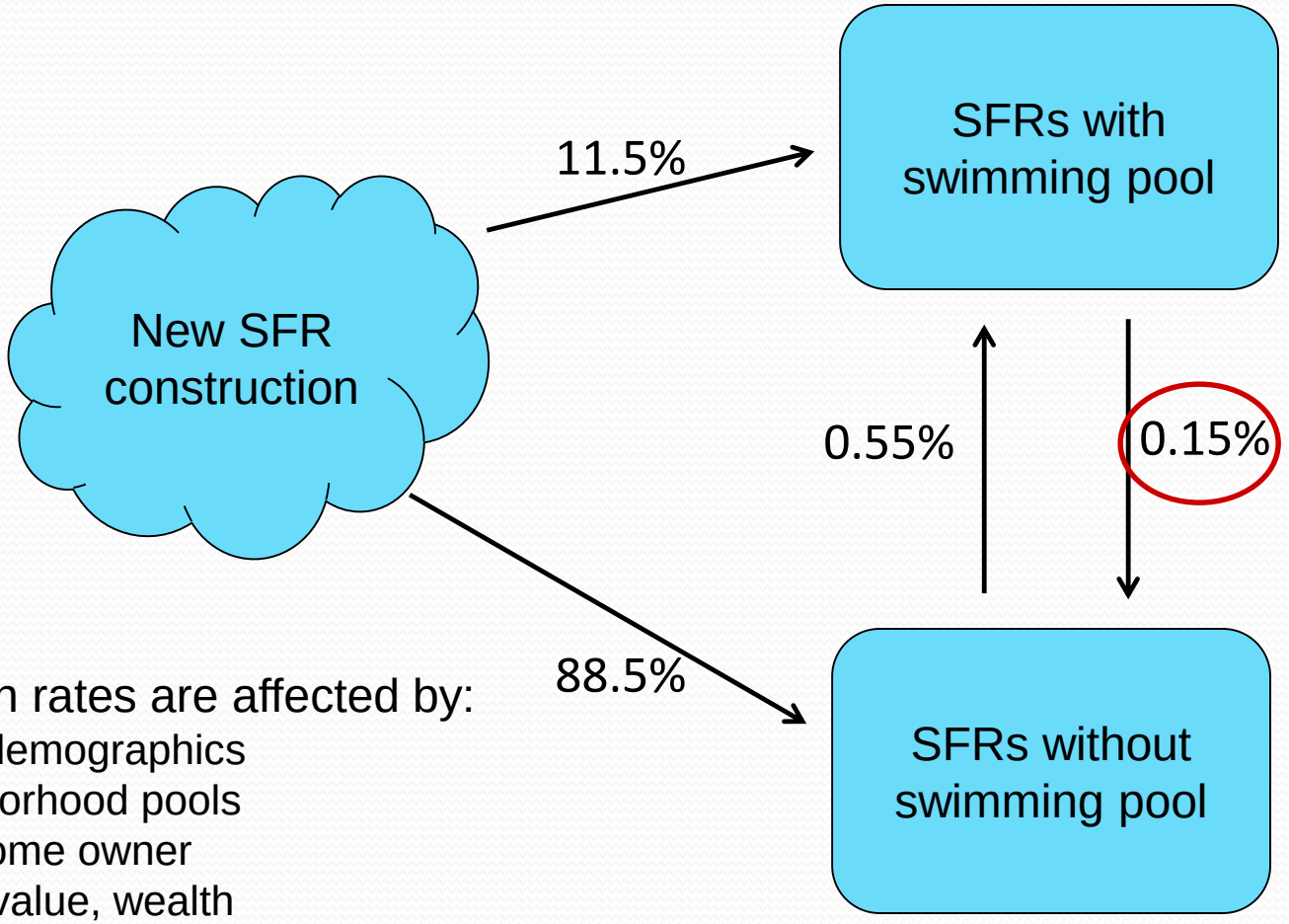
- water (and sewer) rate increases
- more effective water conservation programs
- declining household sizes (PPH)
- changing tastes in landscaping
- more water-efficient fixtures and appliances in new housing
- replacement of inefficient fixtures, appliances in older homes
- more seasonal residents
- shrinking lot sizes
- declines in popularity of backyard pools, use of pool covers
- evaporative coolers replaced by air conditioning

Outdoor water uses - pools



20% of SFRs have a pool, but the popularity appears to have been in decline for decades.

Home swimming pools and transition rates



Transition rates are affected by:

- PPH, demographics
- neighborhood pools
- new home owner
- home value, wealth

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When do anecdotes become a trend?

Maybe when humorists start to notice….

F Minus, *Arizona Daily Star*, Jan. 5, 2013

…or maybe when someone discovers a profit motive.

ARCSA
American Rainwater Catchment Systems Association

Webinar:
Swimming pools converted to rainwater harvesting tanks

Swimming pools are fun, but are they worth the time and effort?

Feb. 26, 2013

See how you can save time and money by converting a swimming pool to a rainwater harvesting tank.

$20 for Members
$40 for Nonmembers

When it's a home improvement topic in the paper, it's passe.

New uses for old swimming pools

Convert space into useful, attractive landscape features

Mark "Eb" Eberlein, near a pond on his property, put a deck over the swimming pool and created a cistern that stores rainwater for a Painted Hills home's garden and desert landscaping. *Arizona Daily Star, March 7, 2013.*

Pools are not only scarcer, they're shrinking

Swimming pools built today are only a bit more than half the size of pools installed in the 1970s and early 1980s.

What's a spool?

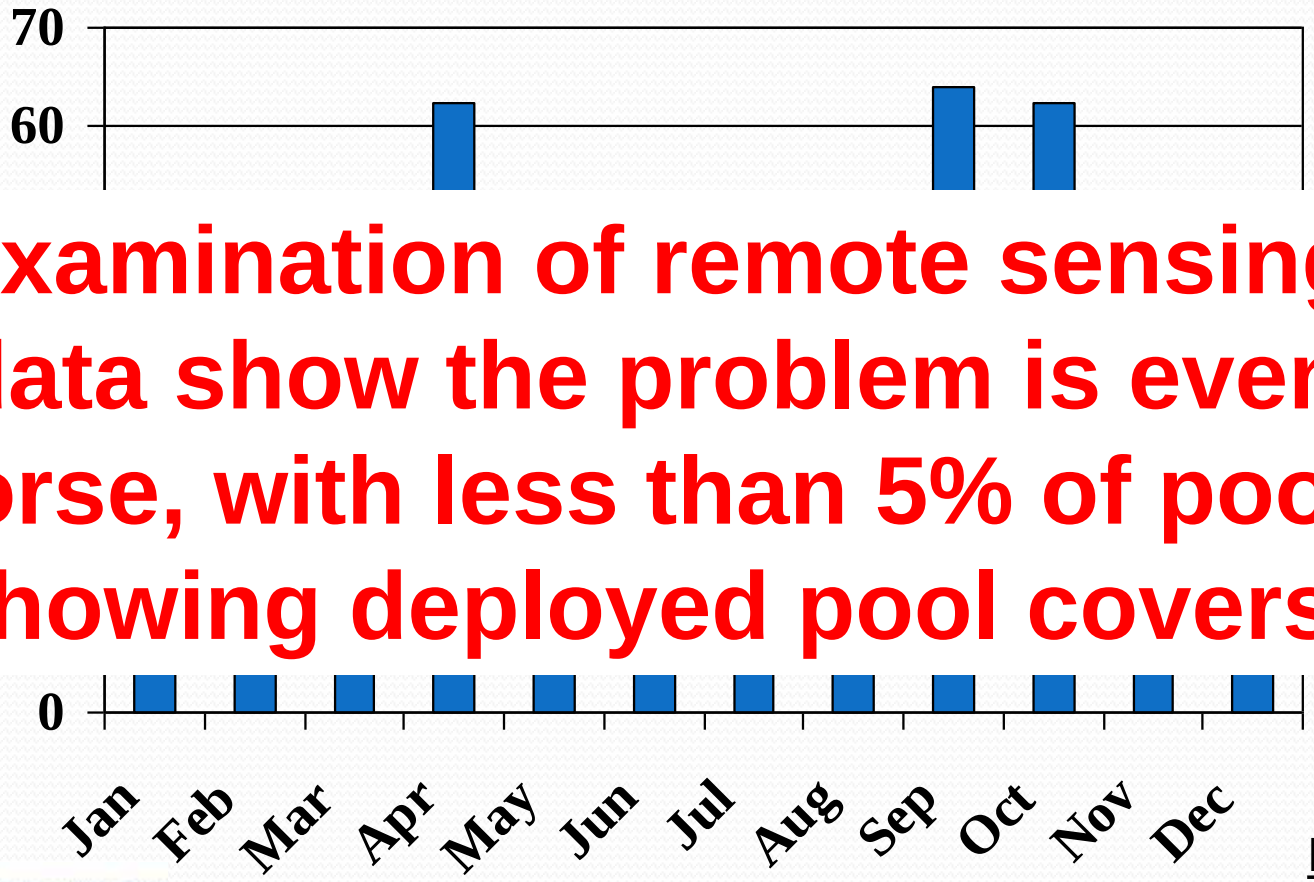
"Stu sure is getting a lot of use out of the new lap pool."

Close to Home by John McPherson, 12 Aug. '13

Typical pools – past, present, future

Pool cover frequency and patterns of use

Roughly 3 out of 5 pool owners report they have pool covers, but most describe them as hard to use. Annual usage patterns show covers are used half the time, mostly to prolong the swim season, in spring and fall.



Examination of remote sensing data show the problem is even worse, with less than 5% of pools showing deployed pool covers.

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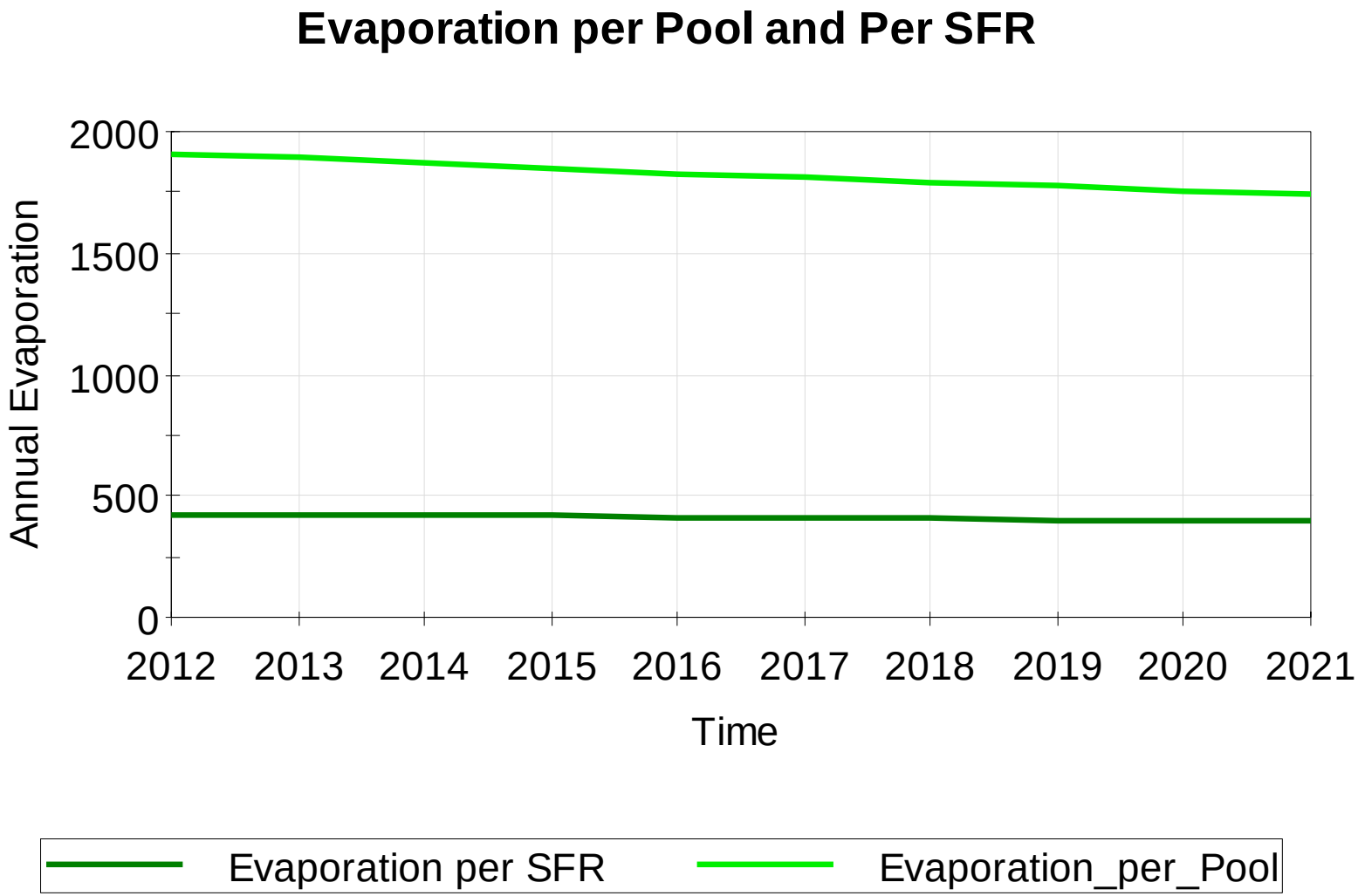
Pool Area

Trend driven by shrinking pools



Backyard pools are becoming:

- less popular
- smaller in size
- used by adults, not families with children
- more likely to be removed

Pools and turf in Pima County:

- 35% of SFRs have some backyard turf
- 22% of SFRs have a backyard pool
- Correlation between turf and pools is ZERO!

What factors are driving backyard turf?

PPH is no longer falling, but households are still changing

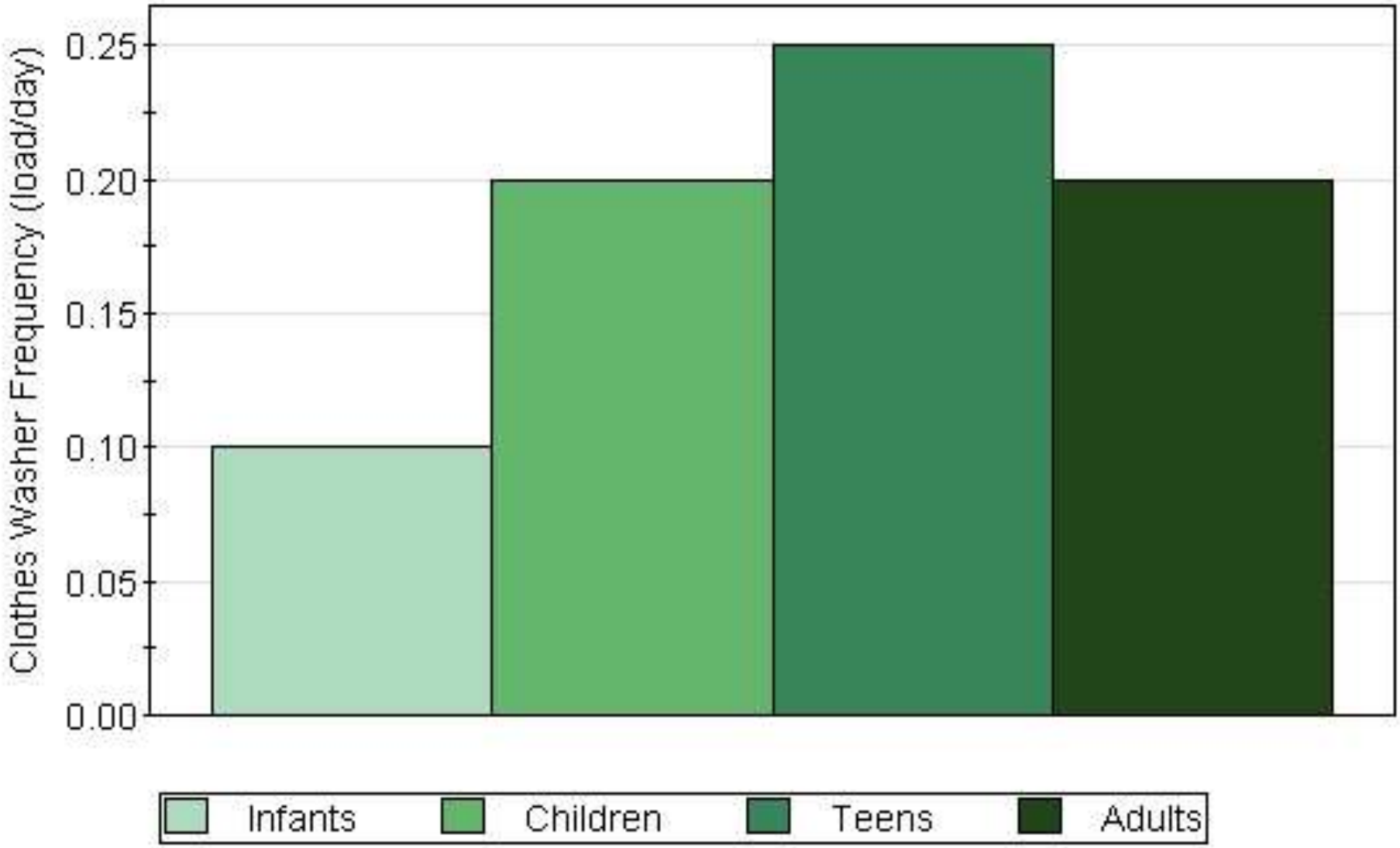
- Fewer infants, children and teens
- More 1-adult households, including with children
- More retirees and snowbirds
- In general, a graying population

Changes in households are affecting frequencies of indoor water uses

Regressions run on AquaCraft WRF data reveal:

- Shower, clothes washer, and dish washer usage is affected by temperature
- Infants don't flush toilets or take showers
- Children account for most baths
- Teenagers really do take more frequent and longer showers than adults
- Most usage rates hold across 9 urban areas

Clothes Washer Loads per Day by Age Cohort in 2020



Reduced turf irrigation due to:

- Abandonment
- Reductions in area
- Replacement with xeriscapes, drought-tolerant plant species
- Restrictions in new construction
- Less winter over-seeding with rye grass
- Replacement with artificial turf

Changing face of the American family

Only 33% of households have children, and the figure is declining.

About 45% of households have at least one dog.

We recently had a Tucson Turf Lawn installed, and with 4 dogs it has made all the difference. The interior of our home is much cleaner without the dogs tracking in dirt from the yard. Thank you! - *Karen F., Tucson, AZ*

I wanted to let you know how much we love and enjoy our new backyard patio with your turf. Even our dog loves it. She rolls and sleeps on it (and doesn't dig or rip at it!).

Source of the quotes and pictures is:
www.tucsonturf.com/testimonials.html
NOTE – ***not one photo or mention of kids.***

Our new puppy loves her new lawn, as do all of us.

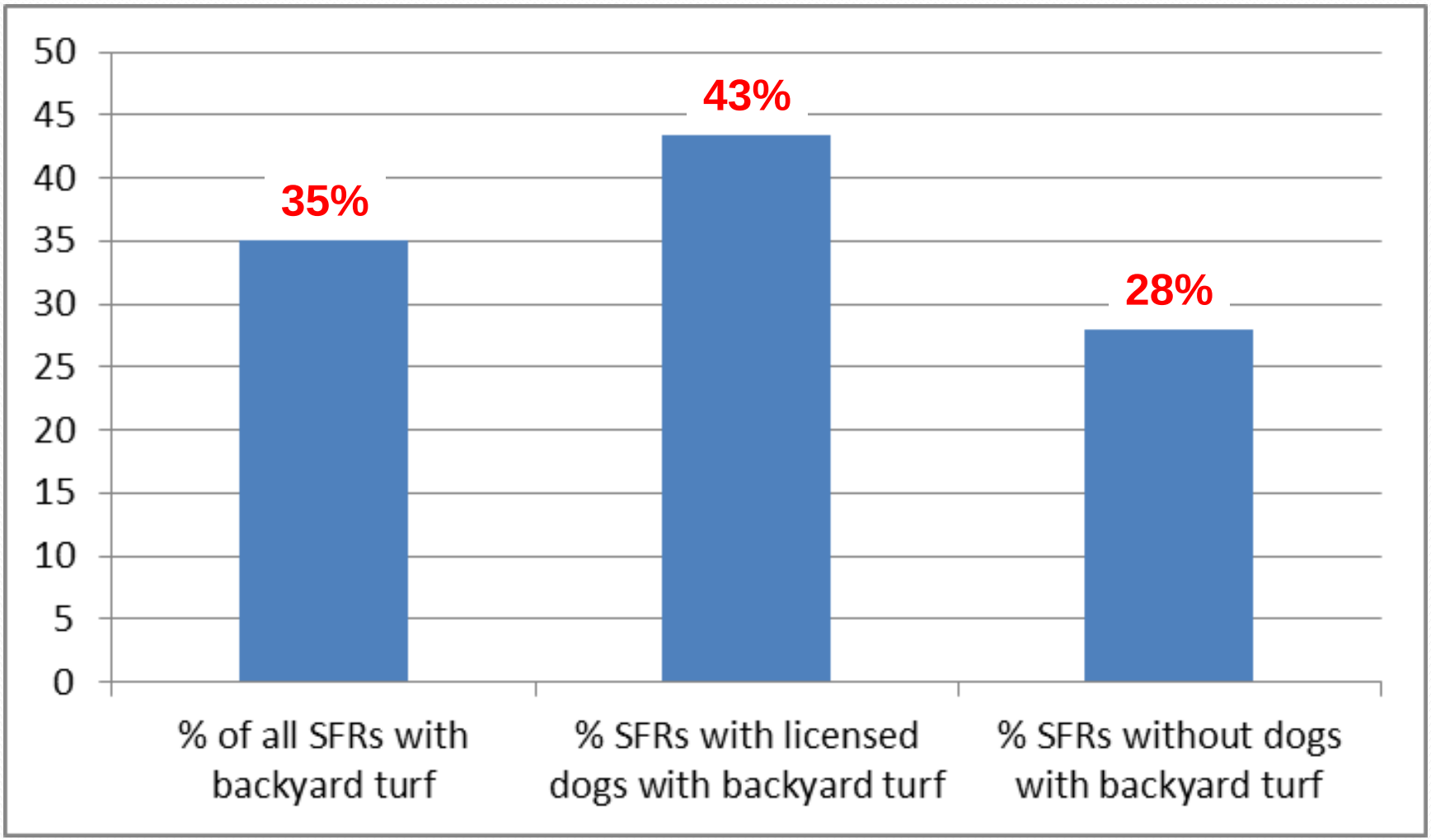
My two small puppies love their new playground. They used to tip-toe around on the rocks - now they run and play like crazy! After playing and chasing each other on the grass for awhile, they love to lay on the grass to catch their breath (and pose for a quick pic). Thanks again. - *Sam*

Dog stats from PACC & PetSmart

- 20% of Pima County households have a licensed dog
- Fewer than half of dogs in Pima County are licenses
- About 45% of households have one or more dogs.

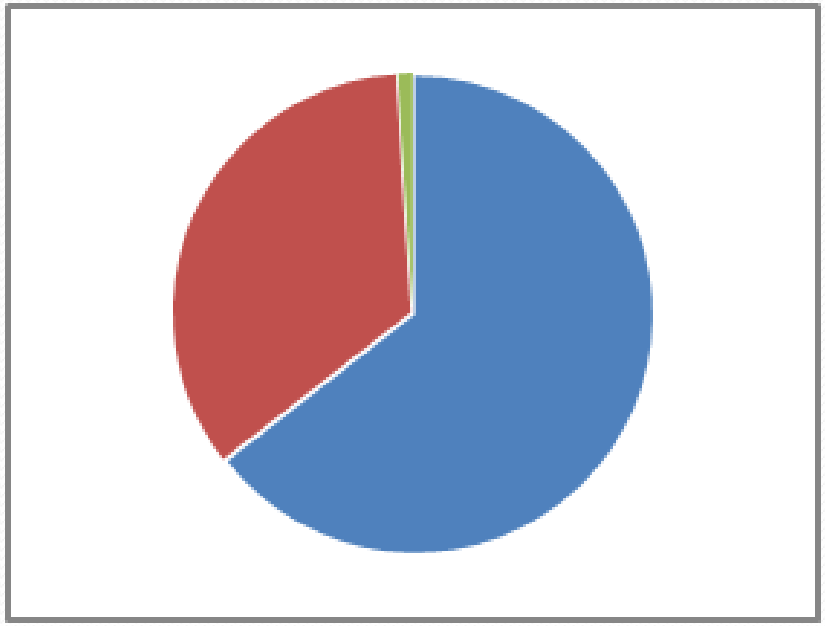
PACC provided a random sample of 500 addresses of licensed dog owners.

Dog ownership and backyard turf are definitely correlated

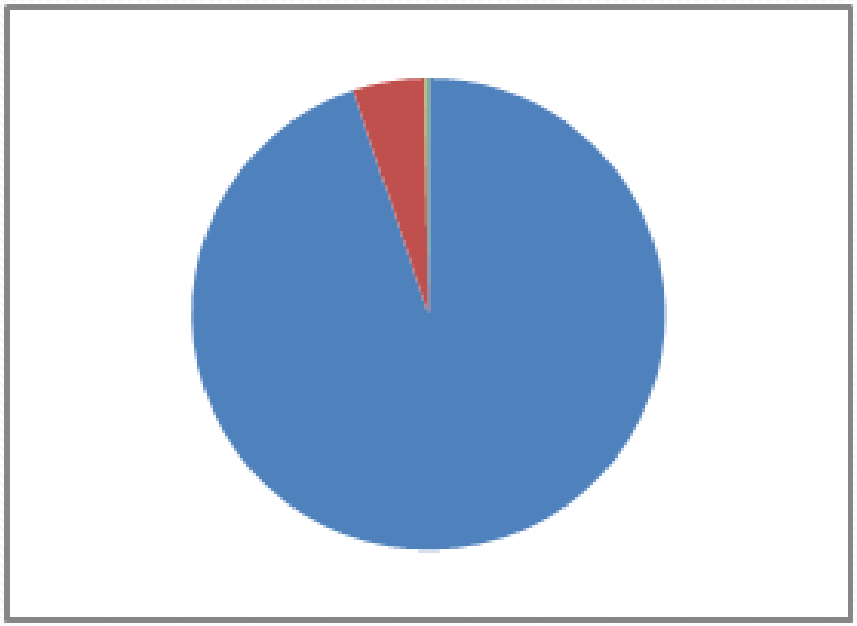


Outdoor water uses – evaporative coolers

35% of SFRs have an evaporative cooler.

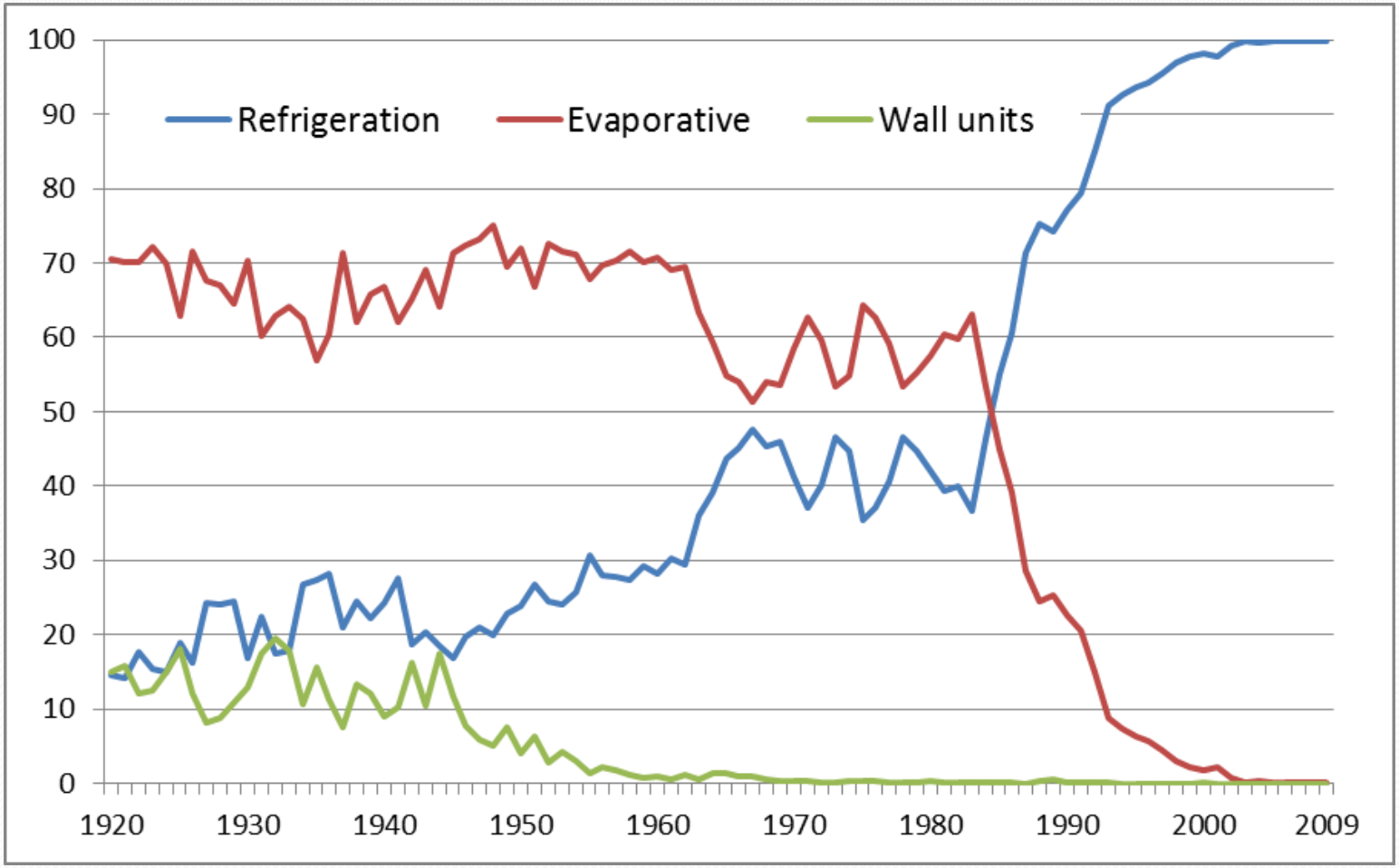


Only 5% of SFRs built since 2002 have one.

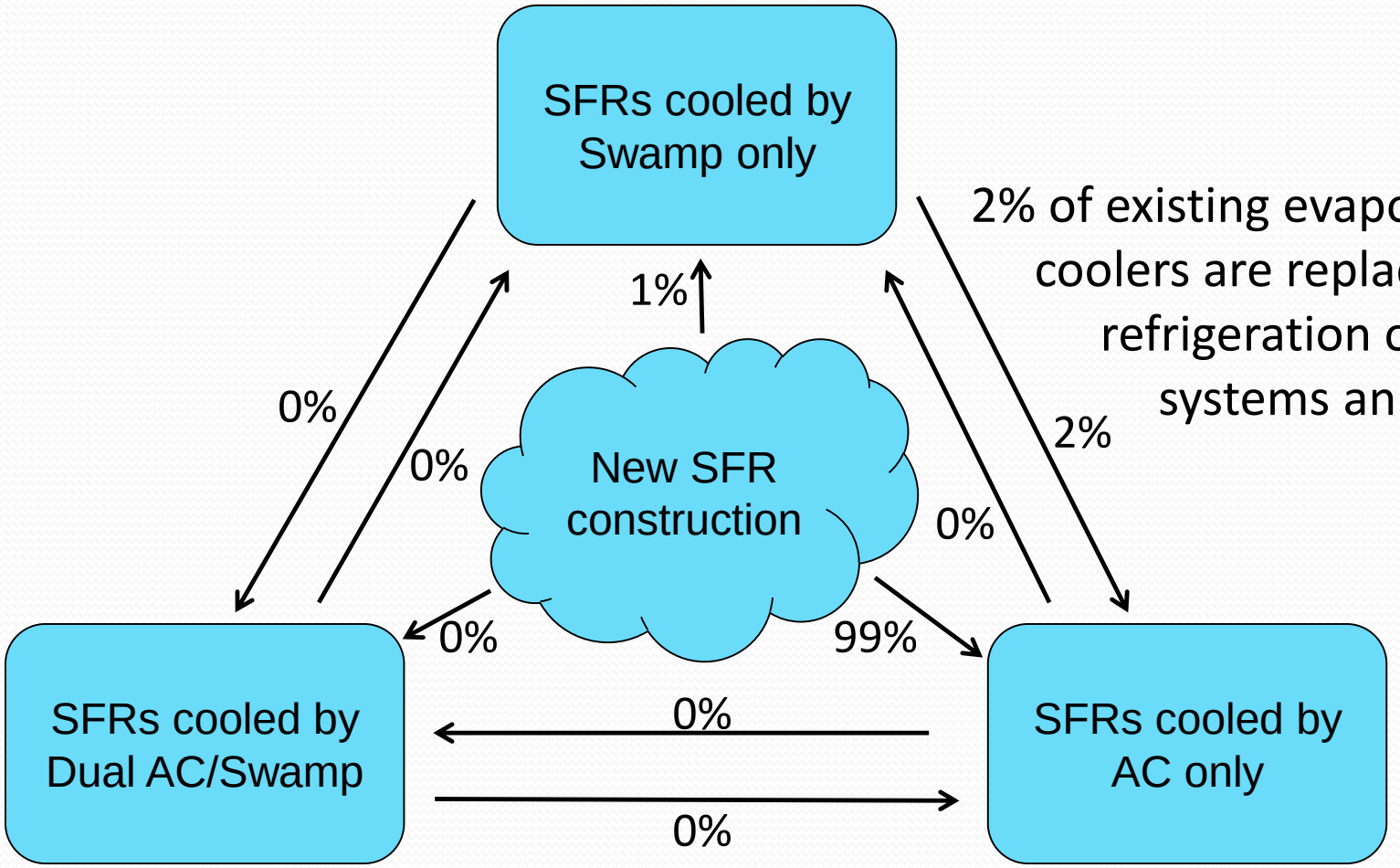


Central AC Unit **Evaporative Cooler** **Wall**

Other outdoor water uses – swamp coolers



Home cooling options and transition rates



2% of existing evaporative coolers are replaced by refrigeration or dual systems annually.

Virtually all new homes have cooling by refrigeration.

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The concept of a *trigger*

Why does someone decide today to put in a pool, or to replace their evaporative cooler with AC, or to buy a horizontal-axis clothes washer?

Why today and not yesterday, or a month ago?

What triggers these types of decisions?

Transitions can be triggered by:

- new home owners
- switch between owner-occupied and rented
- major home renovation
- water-using fixture or appliance or landscape dies
- targeted conservation program, e.g., rebate
- having kids / empty nest syndrome
- contagion effect – the neighbors do something
- drought, price shock, recession, etc.

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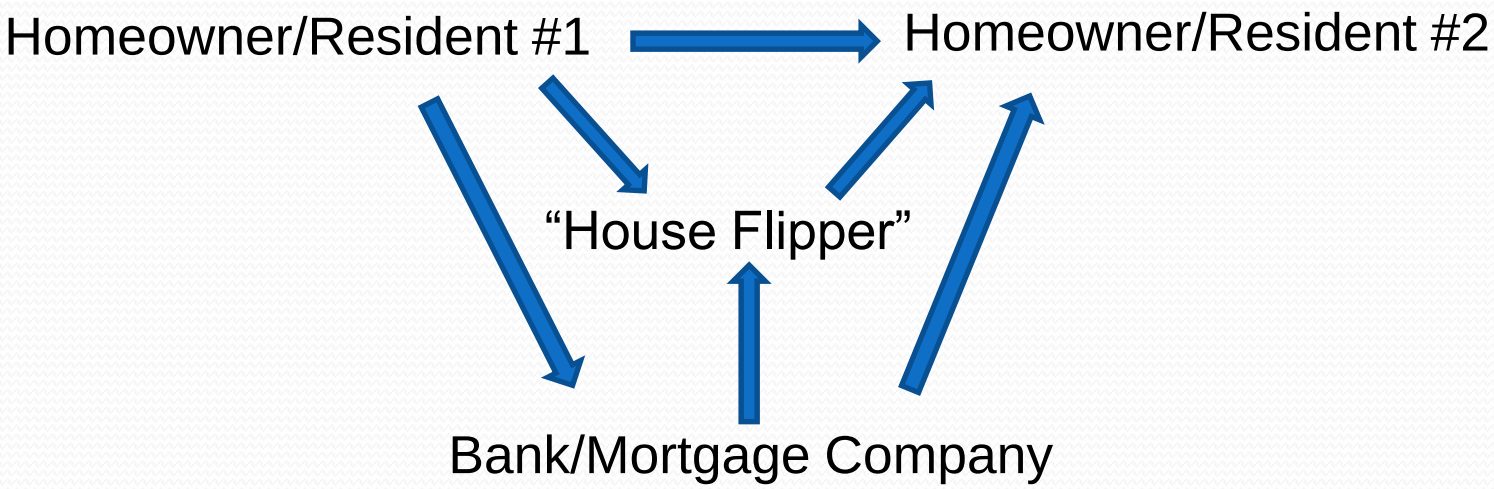
Home ownership transfers



How many foreclosed homes have landscapes die due to irrigation turned off or system failure?

How many homes that are "flipped" have bathroom remodels and/or new washer/dryers installed?

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Is house flipping a water conservation trigger?

What is effect of house flipping on demand?

A house with 3 owners within 1 year is likely to:

- be over 10 years old and not well-maintained
- get new water-efficient fixtures in bathrooms and kitchen
- have one or more new water-using appliances
- have its landscaping reduced
- be sold to an investor and then rented

One major trigger – it died

End of useful life for appliance or fixture can trigger water savings because:

- new appliances and fixtures are increasingly efficient
- voluntary standards have become de facto standards

Landscape vegetation also has a finite lifespan, and landscapers are planting more drought-resistant species

Swimming pools never die of natural causes, but old ones may be removed.

Not understanding or denying the trend creates planning challenges…

Water providers, wholesalers, wastewater plant operators, water regulatory agencies must adjust:

- optimal timing of capital improvements
- acquisition of new supplies
- rate setting
- budgeting uncertainties
- design of water conservation programs
- reuse of reclaimed water

…and some unintended consequences

Lower demand in new developments means:

- fire flows increasingly determine pipe sizes
- water stays in distribution system longer – “water age”
- more chlorine must be added, at new points
- water becomes warmer

All this results in more disinfection byproducts, such as THMs, and can lead to more hydrant flushing or DBP treatment.

Recap and Conclusions - 1

Three factors are driving declines in domestic demand:

- Adding new, water-efficient houses to existing housing stock
- Active conservation efforts – program-related
- "Passive conservation" driven by changes in tastes and preferences and more efficient devices

In most cases, active conservation is the third most important factor, but it often gets all the credit/blame.

Recap and Conclusions - 2

- We are far past peak cooler
- We are well past peak lawn
- We appear to be near peak pool

Average consumption forecast for Pima County:

Outdoor

- **Pools: gradual decline**
- **Evap Coolers: gradual exponential decline**
- **Turf: front yards all but gone, backyard gradual decline**

Recap and Conclusions - 3

- Municipal demand is de-coupled from population; GPCD declines exceeding growth
- Attributing all or most of declines to active conservation is iffy
- Even without active conservation, indoor GPCD will continue to decline for many years
- We now have improved ability to model and forecast indoor demand – time to use it!