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Evaluation of California Weather-Based "Smart" Controller Programs

Results and Perspective on a Large Field Study

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Project Funding Provided by California Department of Water Resources

Project Team

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WATER ENGINEERING & MANAGEMENT

California Urban Water Conservation Council

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

What are Smart Controllers?

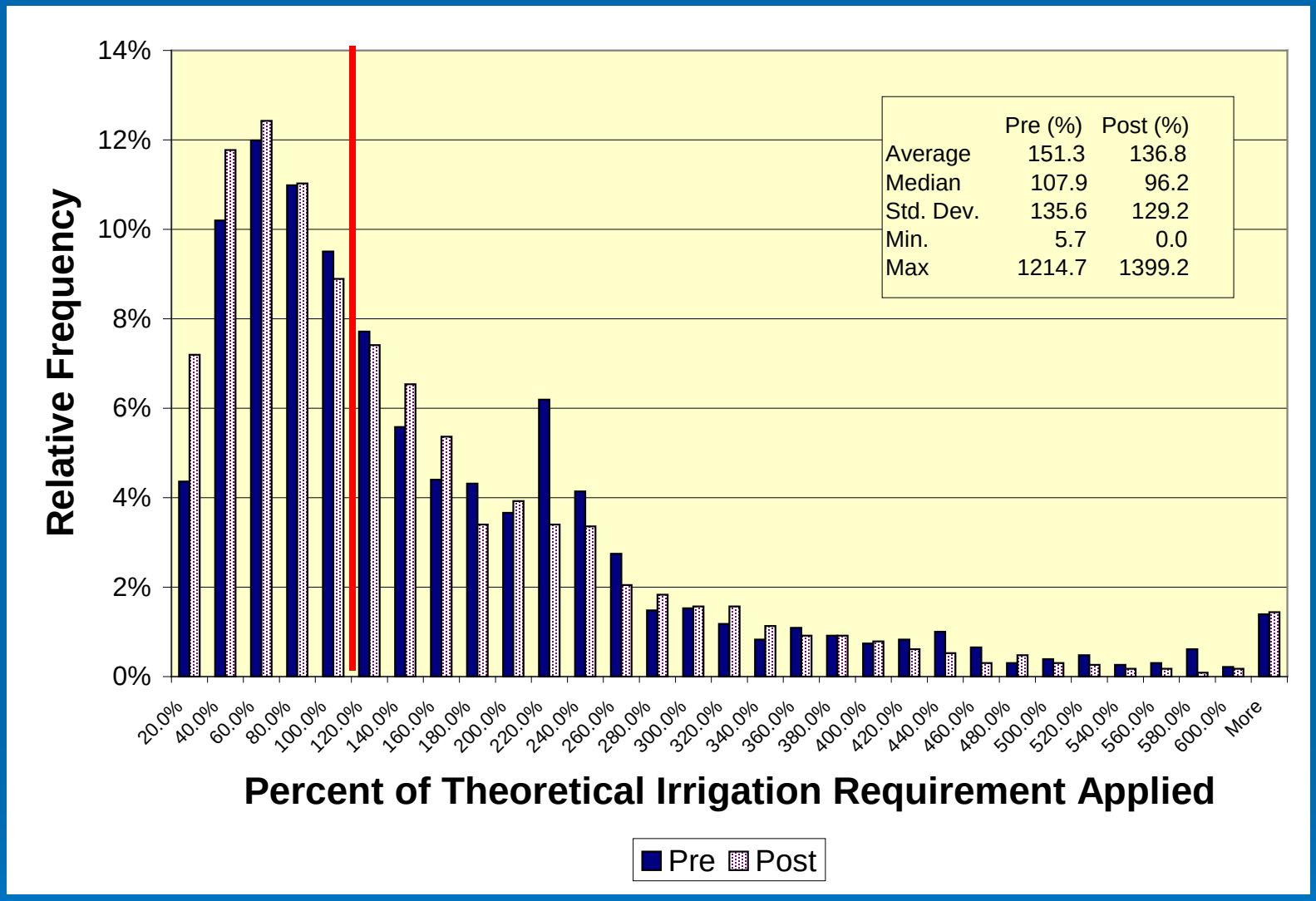
Smart irrigation controllers – aka "weather-based irrigation controllers" utilize prevailing weather conditions, current and historic evapotranspiration, soil moisture levels, and other relevant factors to adapt water applications to meet the estimated needs of plants.

Evaluation Project

- 4 year research study
- Process Evaluation
- Impact Evaluation
- Customer Survey
- Agency Survey
- Water Savings Analysis
  - Weather-normalized consumption data (pre and post)
  - Irrigated area
  - CIMIS ET data
- Cost-Effectiveness Analysis

Study Site Summary

Category	All Sites	Northern Sites	Southern Sites
Total	2,294 (100.0%)	411 (17.9%)	1883 (82.1%)
Customer Category			
Single-Family Residential	1,987 (86.6%)	295 (12.9%)	1,692 (73.8%)
Multi-Family, Commercial, and Other Non-Residential	296 (12.9%)	105 (4.6%)	191 (8.3%)
Irrigation only	11 (0.5%)	11 (0.5%)	
Installation Method			
Self-Installed	1,374 (59.9%)	182 (7.9%)	1193 (52.0%)
Professional/Utility	919 (40.1%)	229 (10.0%)	690 (30.1%)
Climate Zone			
Coastal	655 (28.6%)	67 (2.9%)	588 (25.6%)
Intermediate	1,444 (62.9%)	330 (14.4%)	1114 (48.6%)
Inland	195 (8.5%)	14 (0.6%)	181 (7.9%)



Pre-Smart Controller – 52.1% of sites applied in excess of TIR, 12.7% applied >3x TIR

Post-Smart Controller – 47.8% of sites applied in excess of TIR, 11.4% applied >3x TIR

Change In Water Use

Site Location	Weather-Normalized Total Change in Water Use		
	kgal	hcf	acre-feet
All Sites	-108,418.5	-144,941.9	-330.0
Northern Sites	-50,215.0	-67,131.2	-152.8
Southern Sites	-58,203.4	-77,810.7	-177.1

Change in Water Use II

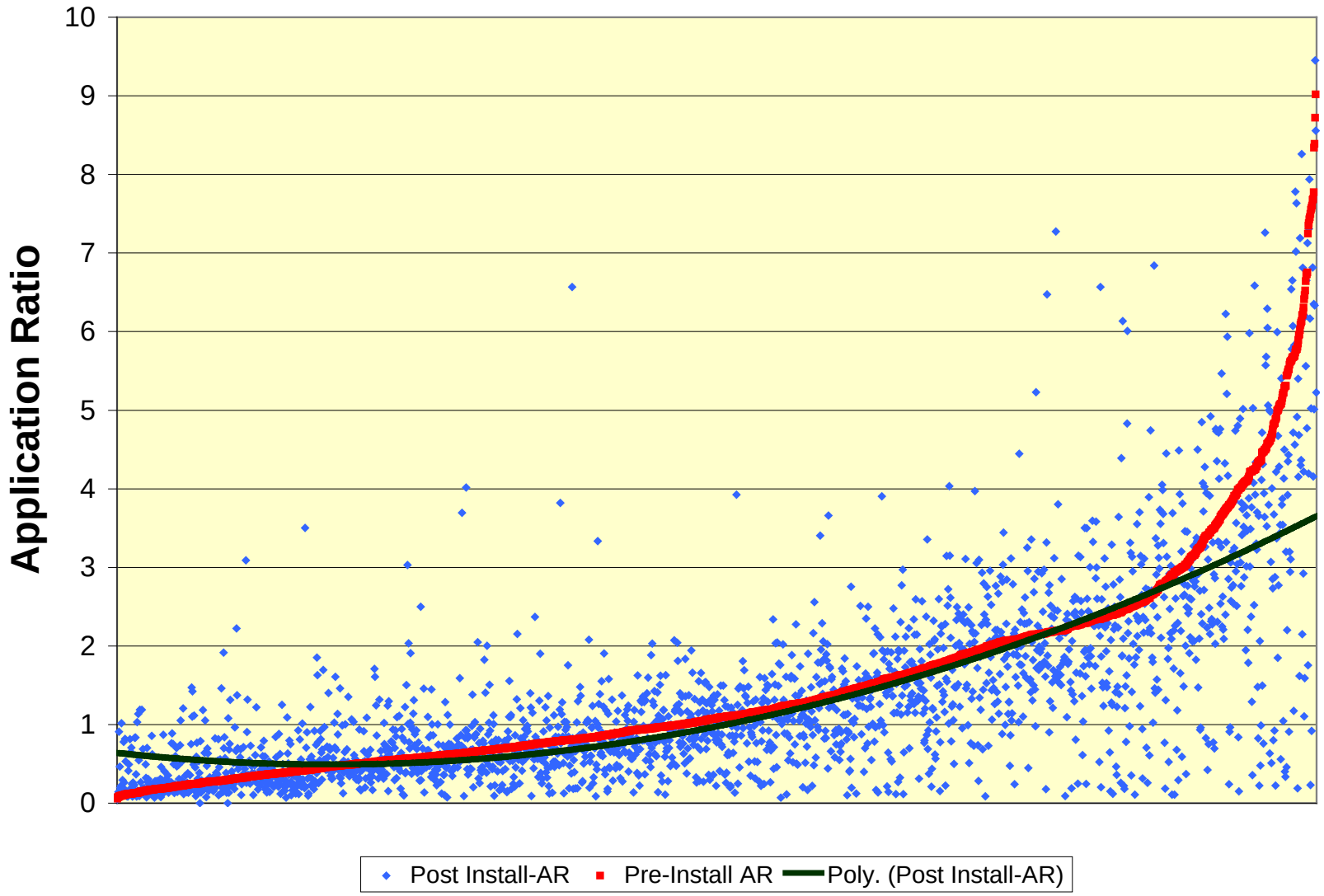
Site Locations	Weather-Normalized Change in Outdoor Use Descriptive and Validatory Statistics					
	N	Mean	Std. Deviation	95% Conf. Boundary	Statistically Significant Reduction?	% Change
All Sites	2294	-47.3	669.5	27.4	Yes	-6.1%
Northern Sites	411	-122.2	1305.2	126.2	No	-6.8%
Southern Sites	1883	-30.9	416.5	18.8	Yes	-5.6%

Water use in kgal.

Change in Water Use III

Site Location	N	Area (sf)		Weather-Normalized Change in Outdoor Water Use				
				Per Site Change In Irrigation Volume (kgal/year)		Gallons/Square Foot		% Change in Outdoor Use
		Mean	Median	Mean	Median	Mean	Median	Mean
All Sites	2294	28385.7	6534.0	-47.3	-6.5	-1.7	-1.0	-6.1%
Northern Sites	411	73132.6	23786.0	-122.2	-15.6	-1.7	-0.7	-6.8%
Southern Sites	1883	18618.9	4313.2	-30.9	-5.7	-1.7	-1.3	-5.6%

Comparison of Pre and Post Application Ratios



Comparison of Results by Pre-Application Ratio and Excess Use Analysis

Statistic	Pre-Application Ratio <=100%	Pre-Application Ratio > 100%
N	1079	1215
N %	47.0%	53.0%
Irrigated area (sf)	30,819	26,225
Avg. Pre-Application Rate (in)	19.9	85
Avg. Post-Application Rate (in)	24.1	77.6
Avg. Pre-Application Ratio (%)	55.2%	236.6%
Avg. Post-Application Ratio (%)	64.1%	201.4%
Avg. ΔAR	0.089	-0.353
Avg. Weather-Normalized Change in Outdoor Use (kgal)	1.49	-90.6
% Change in Weather-Normalized Outdoor Use	0.43%	-7.8%
Avg. Post-Installation Outdoor Use (kgal)	361.4	1,108.3
Avg. Post-Install Excess Use (kgal)	-329.8	487.5
Post-Use that is Excess (%)	NA	44.0%

Factors that Influenced Water Savings

- Pre-smart controller Application Ratio – the level of over (or under) irrigation before installation of smart controller
- Installation method (self vs. professional)
- Participating agency (sometimes significant)

Factors that Did Not Influence Water Savings

- Site classification (residential vs. non-residential)
- Region (northern vs. southern California)
- Climate zone (coastal, intermediate, inland)
- Smart irrigation control methodology (historical ET, on-site readings, remote readings, soil moisture sensor)

Conclusions

- Smart controllers *reduce* water use – at sites that have historically over-irrigated.
- Smart controllers *increase* water use – at sites that have historically under-irrigated.
- Weather-normalized change in usage averaged -6.1% across all 2,294 sites.

Conclusions 2

- Water savings can be maximized by:
  - **Improved programming**
  - **Targeting over-irrigators**
- Smart controllers are cost-effective for water providers and customers in many cases but not for all utilities and customers.
- Most smart control brands and technologies reduced demands on average, but not all reductions were statistically significant.

Measuring Theoretical Irrigation Requirement (TIR) Accuracy

- Theoretical Irrigation Requirement (TIR)
  - The TIR represents site theoretical irrigation requirement
- Pre-Application Ratio (pre-AR) *(0.76 – 10)*
  - water saving potential before controllers installed

  pre-AR = Estimated site irrigation usage / TIR
- Post-Application Ratio (post-AR) *(0.66 – 10)*
  - water applied after controller installed
  - Goal is to have post-AR equal or slightly less than 1.0

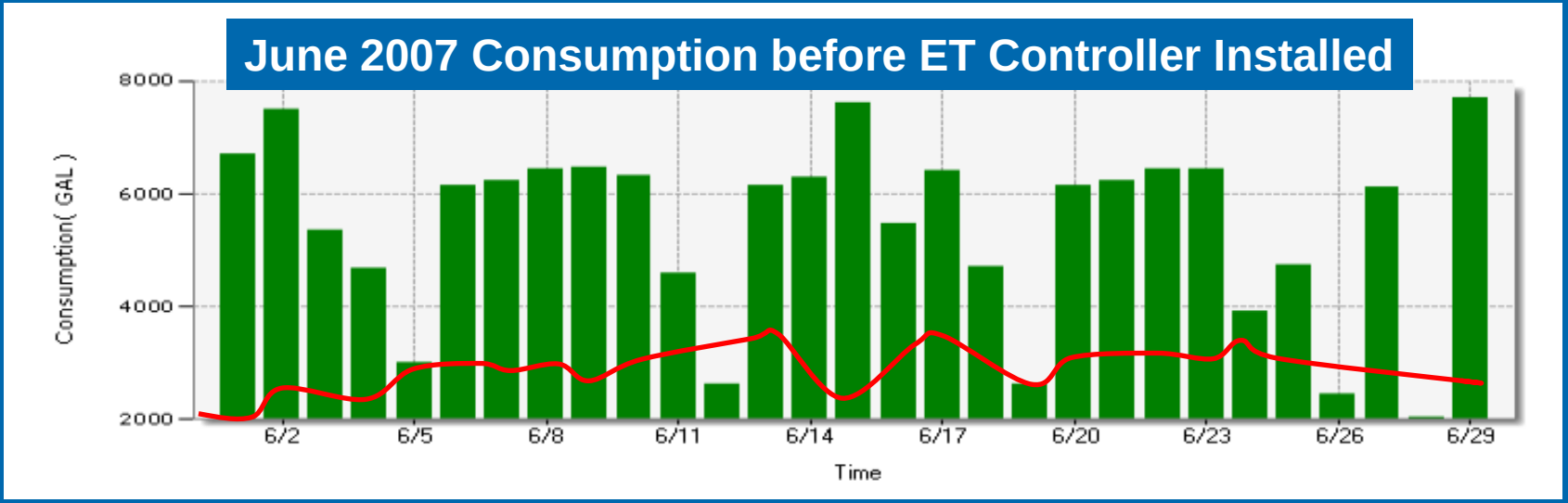
The Blackhawk Project-

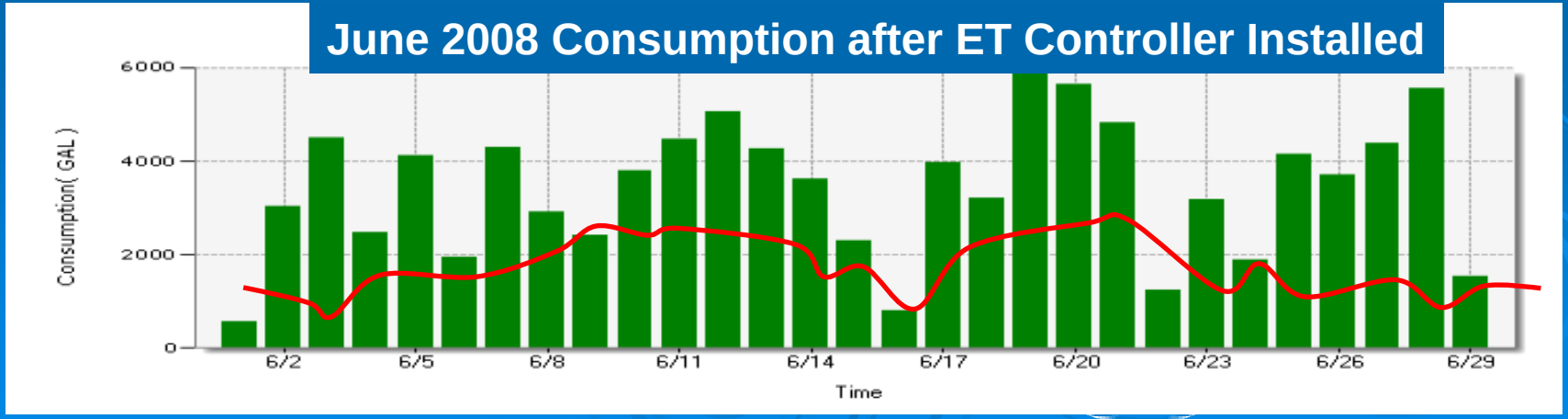
Combines fixed network Advanced Metering Infrastructure with Smart controller technology

- 4,000 smart meters
- 400 smart controllers
- >500 gpd peak irrig./acct.
- 10 Square Miles
- 7 AMI collectors
- Hourly reads
- Meter size ranges from 5/8 to 6 inch
- Start Spring 2010

AMI used to evaluate ET Controller

(42% savings)





Next Steps

- Proceed with combined AMI – Controller pilot study
- Collect additional metered data for all sites (2,605)
- Conduct follow-up on-site investigations
- Fully evaluate value pre-, post-AR = TIR efficiency, applied water budgets and water savings volume
- Update study results (funding to determine # of sites)
- Release updated report or addendum

Final Report Available Now

- www.cuwcc.org
- Agencies will monitor performance for 5 years.
- Contact Peter Mayer with questions.

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