

# Do Increasing Block Rate Water Budgets Reduce Residential Water Demand?

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# Background: EMWD rate change

Eastern switched from uniform rates to increasing block budget-based rates in April 2009:

- *Indoor* water use:  $w_1 = (HHS \times PPA) \times DF + IV$
  - *Outdoor* water use:  $w_2 = (ET \times CF \times IA + OV) \times DF$
  - *Excessive* water use:  $w_3 = \frac{1}{2}(w_1 + w_2)$
  - *Wasteful* water use: in excess of  $w_3$
- } "Water budget"

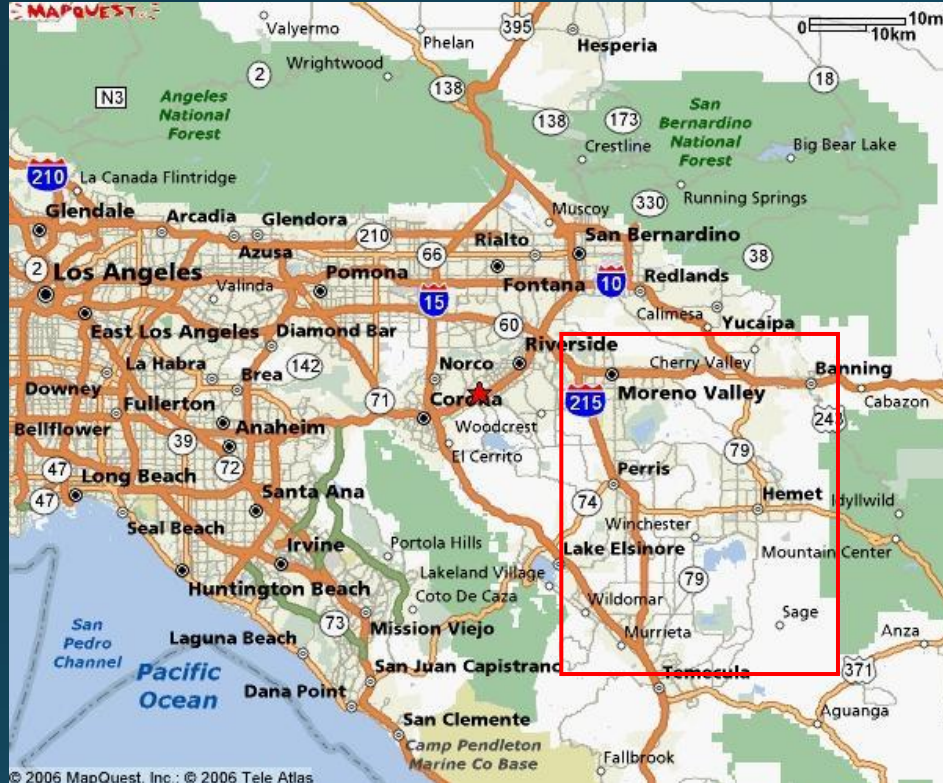
Goal was to promote conservation while maintaining fiscal neutrality

→ **How much did this rate change affect consumption?**

# Data: sources and types

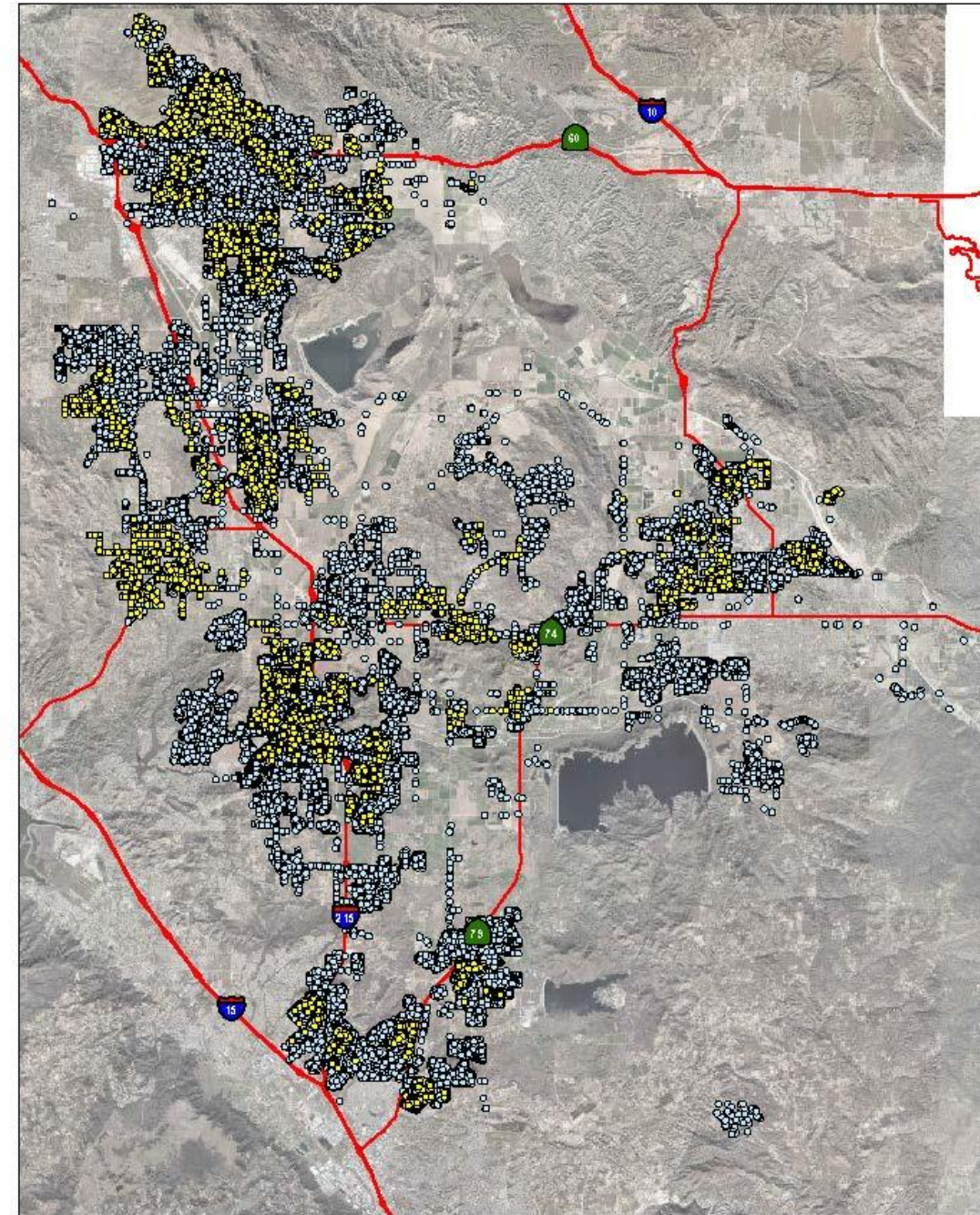
- 12,065 residential accounts (~9% of total) with good spatial coverage
- Continuous records from January 2003 – April 2014
- From EMWD:
  - Pricing, usage, household size, irrigated area, conservation requests, microclimate zone, latitude/longitude
- From other sources:
  - ET: EMWD/Hydropoint, CIMIS
  - Income, education: U.S. Bureaus of Census and Labor Statistics

# Data: spatial distribution of sample households



- Sample accounts
- All water service connections

Image credit: Kristian Barrett, EMWD



# Data: Summary Statistics

Variable	2003	2004	2005	2006	2007	2008	2009		2010		2011	
Usage (CCF/month)	20.70	21.14	20.12	20.77	20.99	19.74	17.77		15.99		15.73	
ET (in/month)	4.67	4.87	4.59	4.73	4.87	4.81	4.70		4.55		4.85	
Nominal price (\$/CCF)	1.43	1.46	1.53	1.62	1.69	1.85	1.93	1.27 2.33 4.17 7.63	2.10	1.43 2.61 4.68 8.56	2.05	1.44 2.64 4.73 8.65
Real price (2010\$/CCF)	1.66	1.66	1.68	1.72	1.77	1.86	1.98	1.30 2.37 4.25 7.78	2.10	1.43 2.61 4.68 8.56	1.98	1.39 2.54 4.55 8.33
Real Income (2010\$/month)	316.26	317.45	318.05	319.20	320.78	316.70	311.07		309.96		309.44	

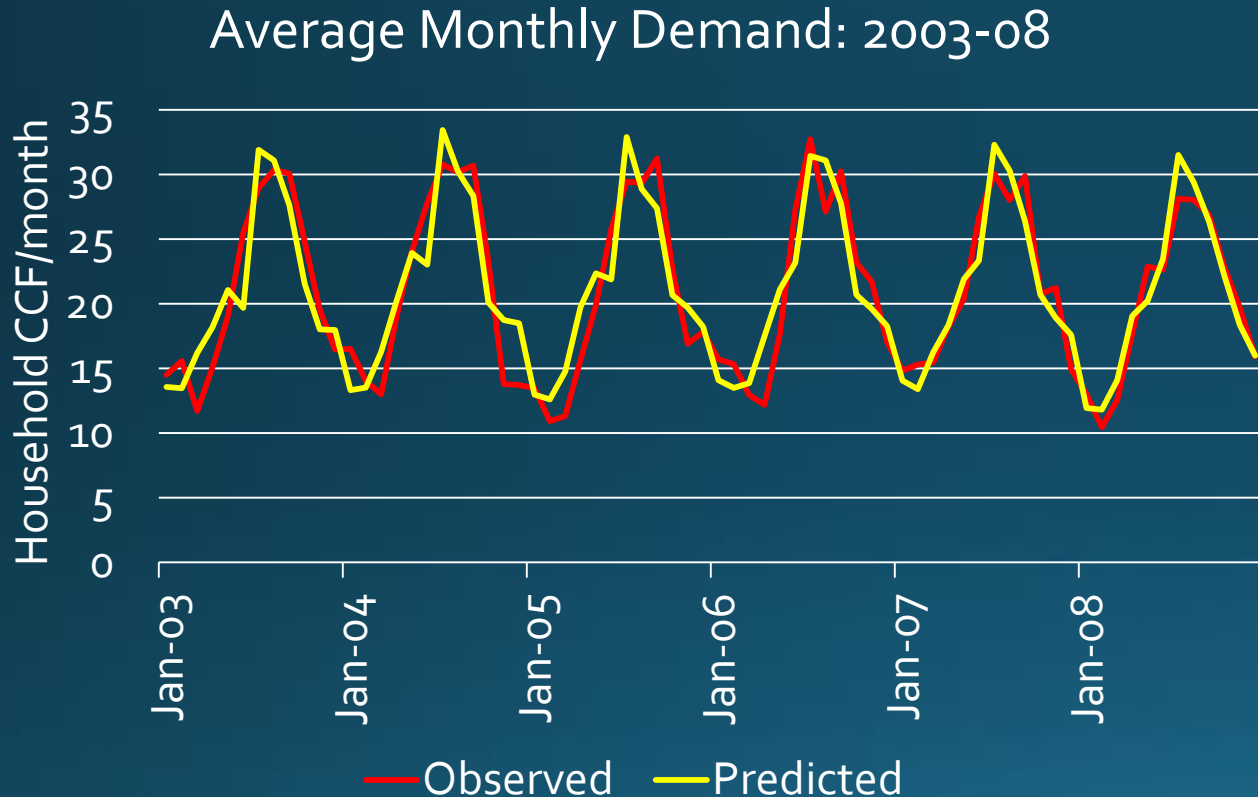
# Estimation strategy

- Estimate a uniform rate demand model using data from January 2003 – December 2008

$$\ln(w_{it}) = \delta z_{it} + \alpha f(p_{it}) + \gamma g(y_{it}) + \varepsilon_{it}$$

- Use the model to predict demand from April 2009 – April 2014 under equivalent uniform prices
- Difference between actual and predicted demand is the water budget-induced demand effect

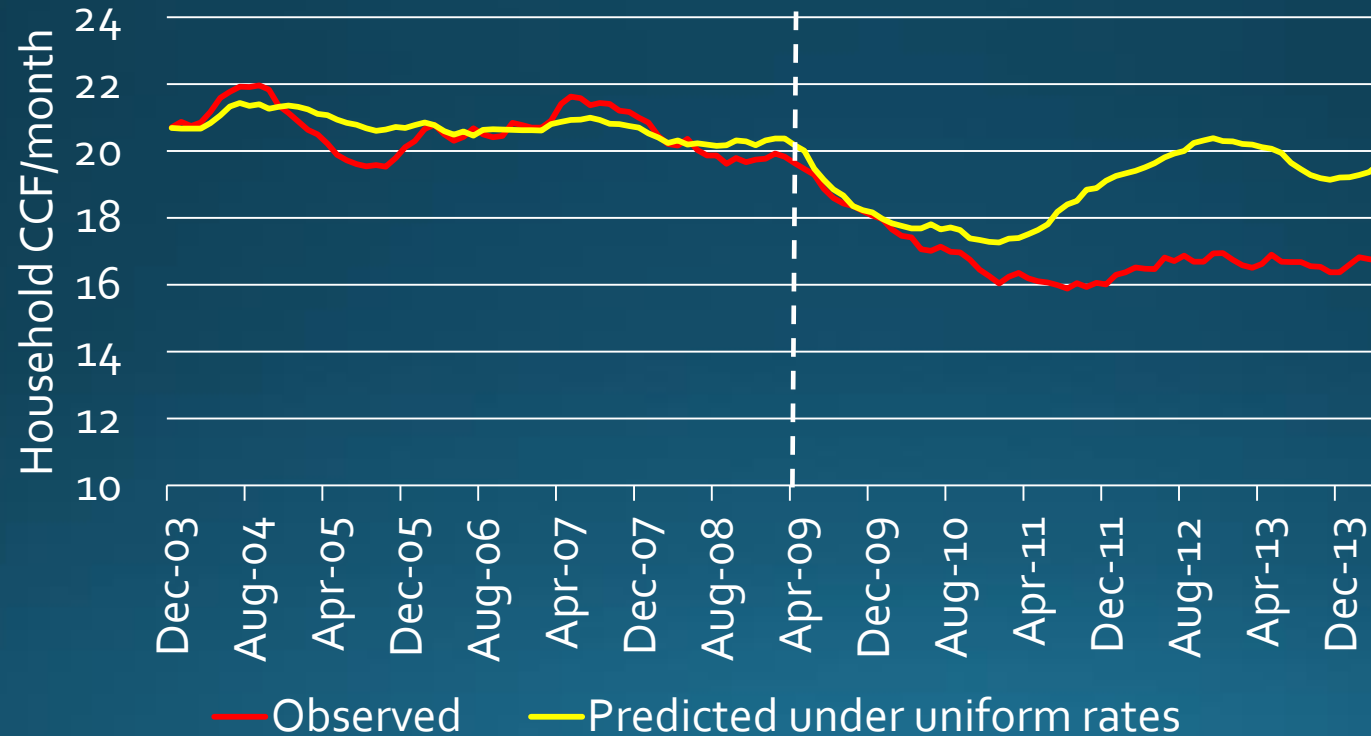
# Estimation results



- Good model fitness
  - $R^2$  values: 0.3 to 0.4
- Intuitive and highly significant coefficients
- Price elasticity: -0.7 to -0.8

# Demand effect emerges about 1 year after the rate change

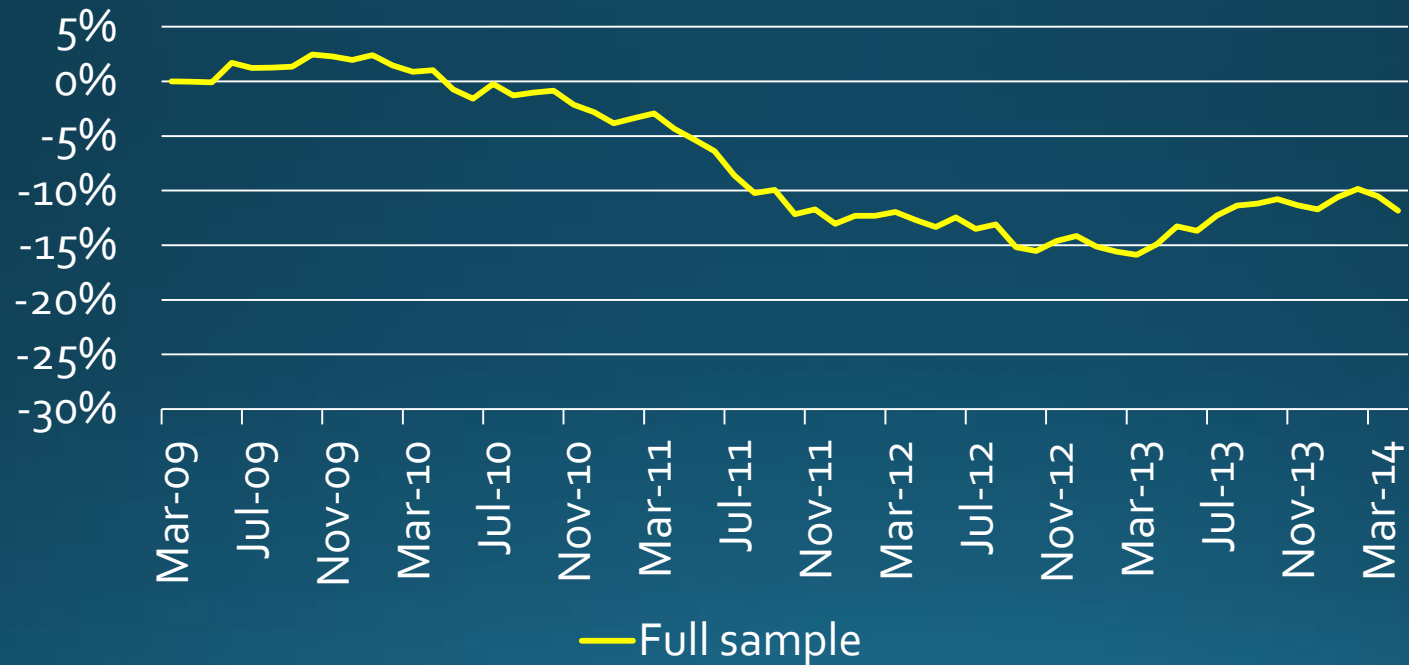
Observed vs. Predicted Demand  
12-month moving average





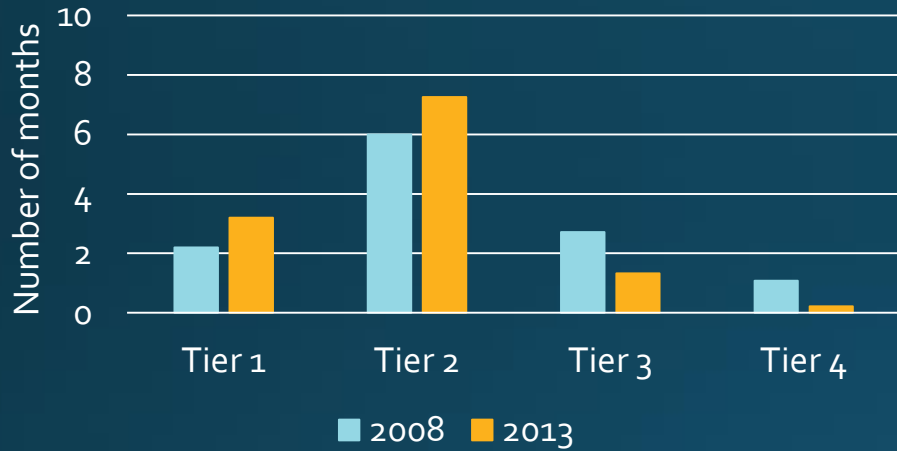
# Some evidence the demand effect has stabilized around 10-15%

Demand reduction attributable to the rate change:  
12-month moving average

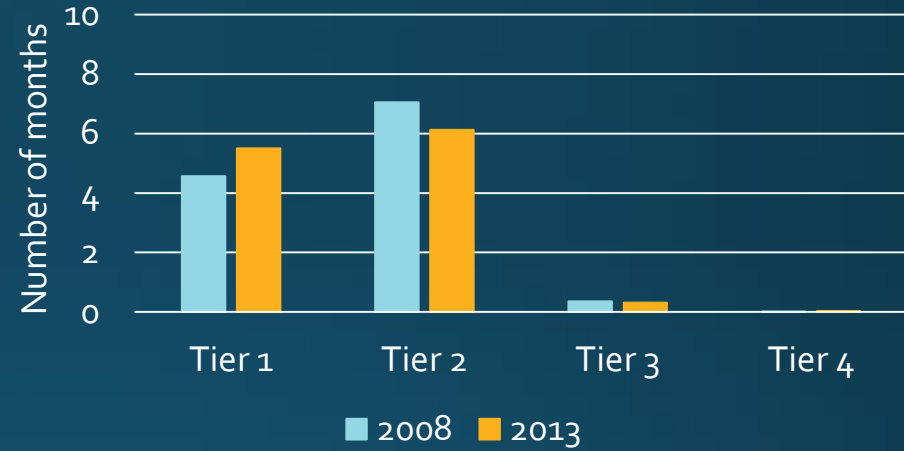


# The rate change has had a bigger effect on inefficient households

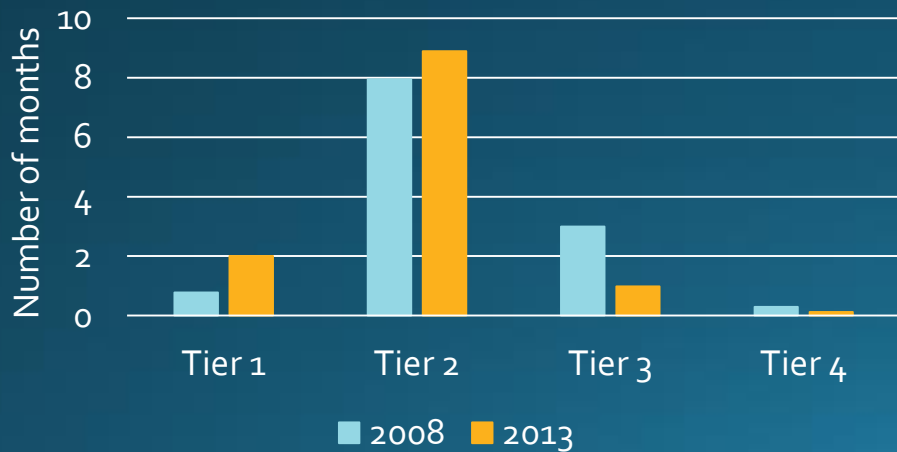
Full Sample: 2.2 → 1.9



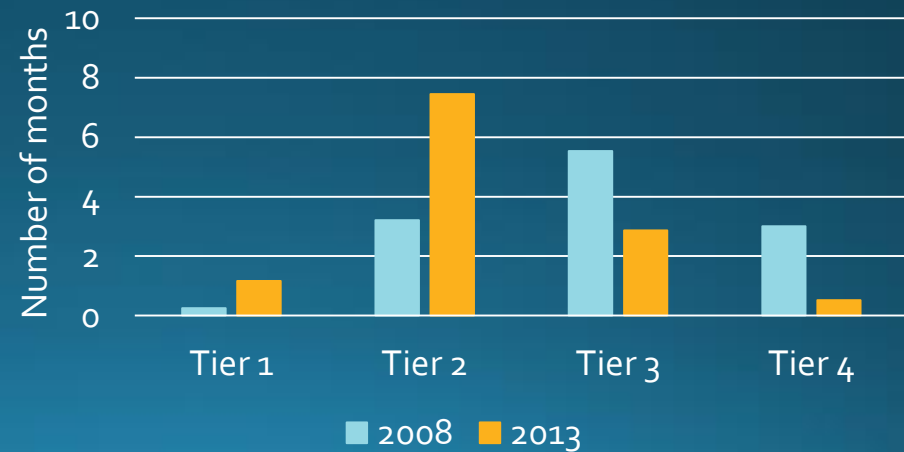
Efficient Households: 1.7 → 1.6



Average Households: 2.2 → 1.9

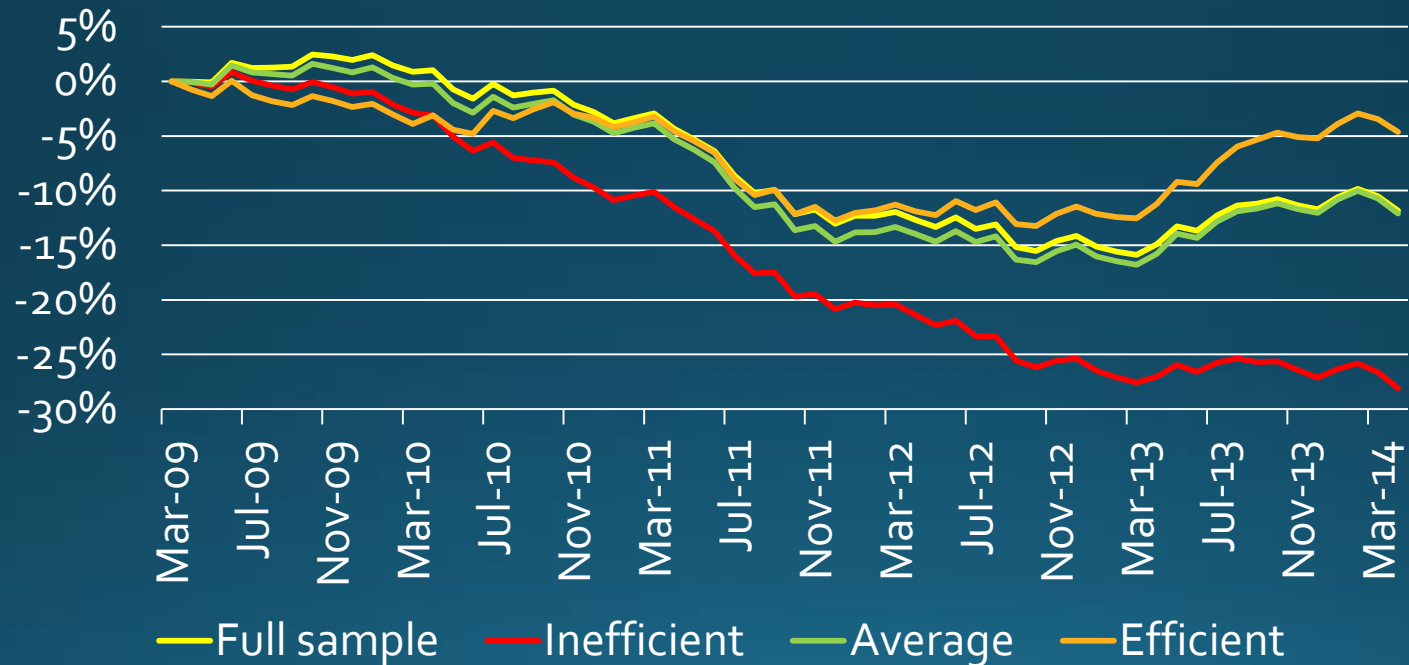


Inefficient Households: 2.9 → 2.2



# Efficiency improvements by inefficient households also have been the most resilient

Demand reduction attributable to the rate change:  
12-month moving average



# Conclusions

- How much did the EMWD rate change affect consumption?
  - *Between July 2011 and April 2014 household usage was 10-15% lower than it would have been under equivalent uniform rates.*
- Real average prices rose ~3% under water budgets, but would have had to rise ~30% under uniform pricing to achieve the same demand effect.
  - *Significant conservation potential while also addressing equity concerns.*
- Conservation gains generally appear resilient to changing conditions that would otherwise tend to increase demand.
  - *Evidence of a price-induced "ratcheting effect": higher prices create new habits that become permanent.*

# Ongoing/Future Work

- Could the effect be partitioned into a price effect and a quantity effect?
  - *Price effect due to higher marginal rates*
  - *Quantity effect due to viewing the budget as a "soft restriction"?*
- Welfare effects
  - *Theoretically consistent welfare estimation under nonlinear pricing is problematic*
  - *Structural estimation of the utility function under block rates complete; prediction and welfare estimation under alternative price structures in progress.*
- Optimal pricing
  - *Welfare maximization subject to revenue and quantity constraints*