

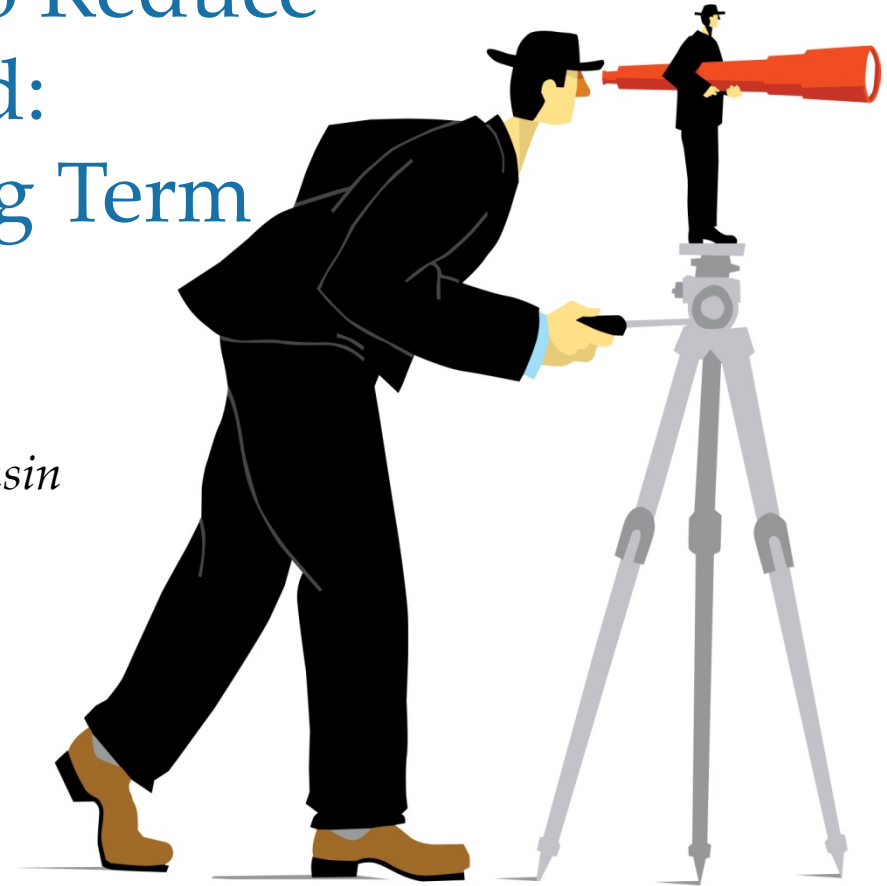
# Using Social Nudges to Reduce Energy Demand: Evidence for the Long Term

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# The Program, I

- SMUD contracted with OPOWER to initiate a behavioral pilot study in its service area beginning in Spring 2008;
- Study involves 85,000 SMUD residential customers;
  - » begins with 35,000 customers enrolled in the program (treatment households), and 50,000 control households;
- Households are **randomly assigned** by census block between treatment and control groups.
  - » Several authors (Costa and Kahn 2010, Ayres, Raseman, and Shih 2009) have established that average household characteristics generally are not statistically or substantively different across the two groups.

# The Program, II

- The program involves mailing home energy reports to households, either quarterly or monthly
  - » In the data set used for the current analysis, 98.8% of monthly reports went to households with baseline energy use greater than about 20 kWh per day;
  - » 83.4% of quarterly energy reports went to households with baseline energy use less than 20 kWh per day;
- Content of the reports:
  - » Energy savings tips, with estimates of the \$value of the savings;
  - » Comparison of electricity use by the home over time;
  - » Comparison of the electricity use to that of “similar” households;
- Caveat: We don't know the relative impact of various parts of the report

# Program, III



JOHN DOE

## Home Electricity Report

Account number: 1234567890  
Report period: 05/01/10 - 06/30/10

We are pleased to provide this personalized report to you.

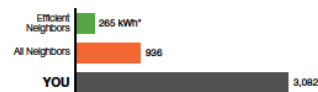
The purpose of this report is to:

- Provide information
- Track your progress
- Share energy efficiency tips

This information and much more available at [smud.org/reports](http://smud.org/reports)

### Last 2 Months Neighbor Comparison

You used **220% MORE** electricity than your neighbors.



\* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

How you're doing:

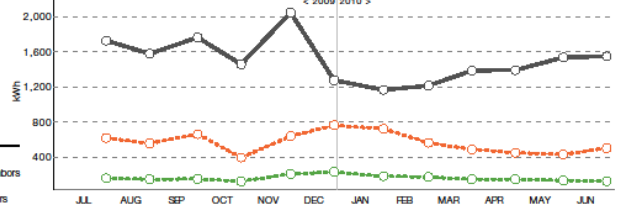
**You used more than average**  
Turn over for ways to save →

#### Who are your Neighbors?

- All Neighbors**  
Approximately 100 occupied, nearby homes (avg 0.62 miles away) that have electric heat
- Efficient Neighbors**  
The most efficient 20 percent from the "All Neighbors" group

### Last 12 Months Neighbor Comparison

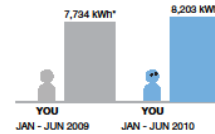
You used **166% MORE** electricity than your neighbors. This costs you about **\$1,541 EXTRA** per year.



Turn over for savings →

### Personal Comparison

How you're doing compared to last year:



So far this year, you used **6% MORE** electricity than last year.

Looking for ways to save? Visit <http://smud.org/reports>

\* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

### Action Steps | Personalized tips chosen for you based on your energy use and housing profile

#### Smart Purchase

Save a lot by spending a little

- Reduce AC costs with fans**  
Fans help you stay cool while reducing your air conditioning costs. Portable fans and ceiling fans keep air circulating, which allows you to raise the room temperature 3-4 degrees and stay just as comfortable.

In the mornings and evenings, you can use window fans to blow cooler air into the home and warmer air out.

You will save about 3-5% on cooling costs for each degree you raise the thermostat.

SAVE UP TO **\$80** PER YEAR

#### Smart Purchase

Save a lot by spending a little

- Clean or replace filters regularly**  
You can improve the energy efficiency of your heating and cooling systems and improve your indoor air quality by checking your filters monthly.

First, remove the filter—it usually slides right out. Next, hold the filter up to a light to see if it is clogged.

You can find a replacement for a clogged disposable filter at your local hardware store for about \$2. Check your manual for cleaning instructions if you have a permanent filter.

SAVE UP TO **\$50** PER YEAR

#### Quick Fix

Something you can do right now

- Keep out the sun's heat regularly**  
Sunlight passing through windows can heat up your home and make your air conditioner work extra hard.

Keep blinds or draperies closed on sunny days to block this heat. You can also purchase and install shade screens, which are another affordable and effective way to keep out the sun's heat.

Blocking sunlight from entering your home will help you stay comfortable and save on cooling costs.

SAVE UP TO **\$125** PER YEAR



[smud.org/reports](http://smud.org/reports) | 1-888-742-SMUD (7883) | [electricityreports@smud.org](mailto:electricityreports@smud.org)  
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# Evaluation after Year 1 of the Program

- Three studies of the program after Year 1:
  - » Costa and Kahn 2010 (CK)
  - » Ayres, Raseman, and Shih (ARS)
  - » Summit Blue (absorbed into Navigant Consulting), 2009
- Results of these studies:
  - » CK: **2.1% overall**
    - Through October 2009, household and monthly fixed effects, sample of  $\approx 81K$ , essentially same result with and without covariates; opt-outs and move-outs remain;
  - » ARS: **2.1% overall, 2.35% for monthly reports, 1.5% quarterly reports**
    - Through April 2009, logged the dependent variable, no fixed effects, sample  $\approx 83,500$
  - » Summit Blue: **2.1% overall, 2.3% monthly, 1.6% quarterly**
    - Through September 2009, DID statistic (2.1% overall with FER); removed opt-outs and move-outs;

# FULL DISCLOSURE

- Navigant hired by OPOWER for this analysis;
- SMUD neither endorses nor challenges this analysis, will do its own third-party analysis in the future.

# Evaluation of Year 1 Program Effect, Cont

- So we have the following results from Year 1:
  - » CK: **2.1% overall**
  - » ARS: **2.1% overall, 2.35% for monthly reports, 1.5% quarterly reports**
  - » Summit Blue: **2.1% overall, 2.3% monthly, 1.6% quarterly**
- Year 1 results in current study:
  - » Remove opt outs (930) and move-outs (12,089) leaves 70,752 households; Program date begins with bill following the report date;
  - » **2.19% (2.03%) , 2.32% monthly, 1.25% (1.18%) quarterly;**
- So we establish that the analysis here is generating basically the same results as for previous studies.

## Research Question:

- Do program savings persist?
  - » Two basic reasons why they might not:
    - Behavioral regression
    - Catch-up by non-participants



# DID Analysis, I

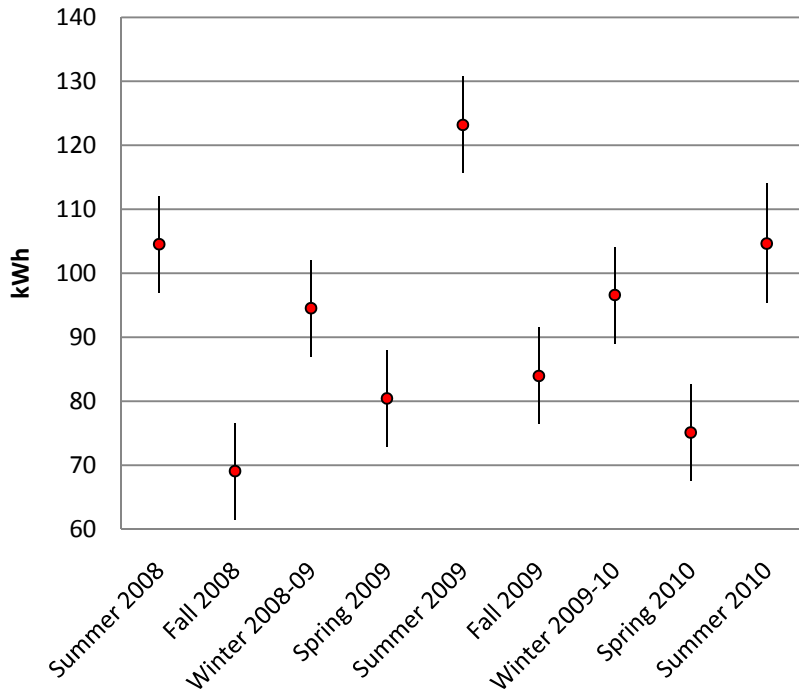
Empirical Evidence: DID analysis, Years 1 and 2

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t + \varepsilon_{kt}$$

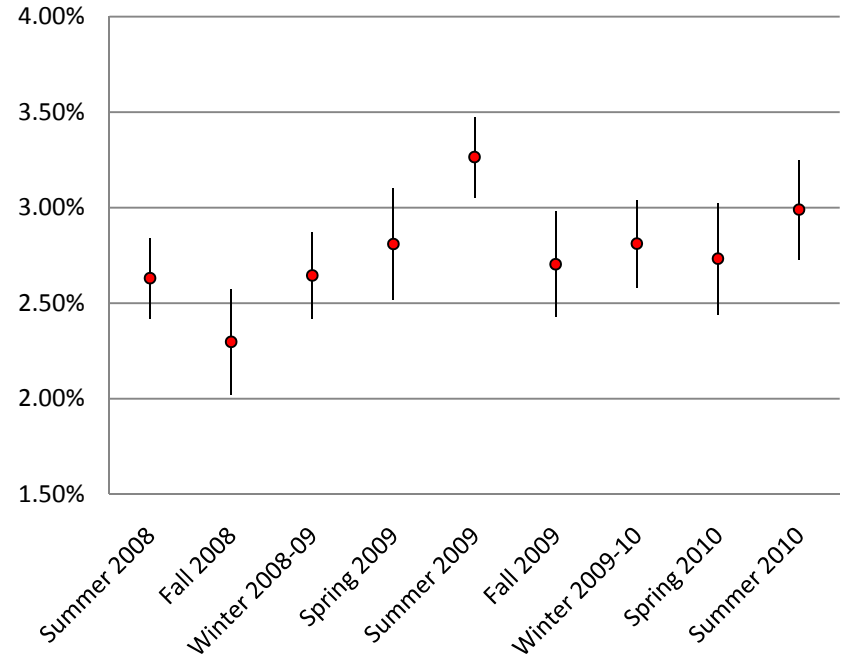
Period	Statistic	Estimate for High Consumption Households (standard error)	Estimate for Low Consumption Households (standard error)
<b>First Year (April 2008- March 2009)</b>	Average percent savings	2.32% (0.11%)	1.25% (0.18%)
	Average savings per customer (kWh)	317 (14)	76 (25)
<b>Second Year (April 2009- March 2010)</b>	Average percent savings	2.89% (0.11%)	1.70% (0.18%)
	Average savings per customer (kWh)	381 (14)	104 (11)

# DID Analysis II: Seasonal Savings, High Consumers

**Program Savings: Estimated Mean Savings with 95% Confidence Intervals**

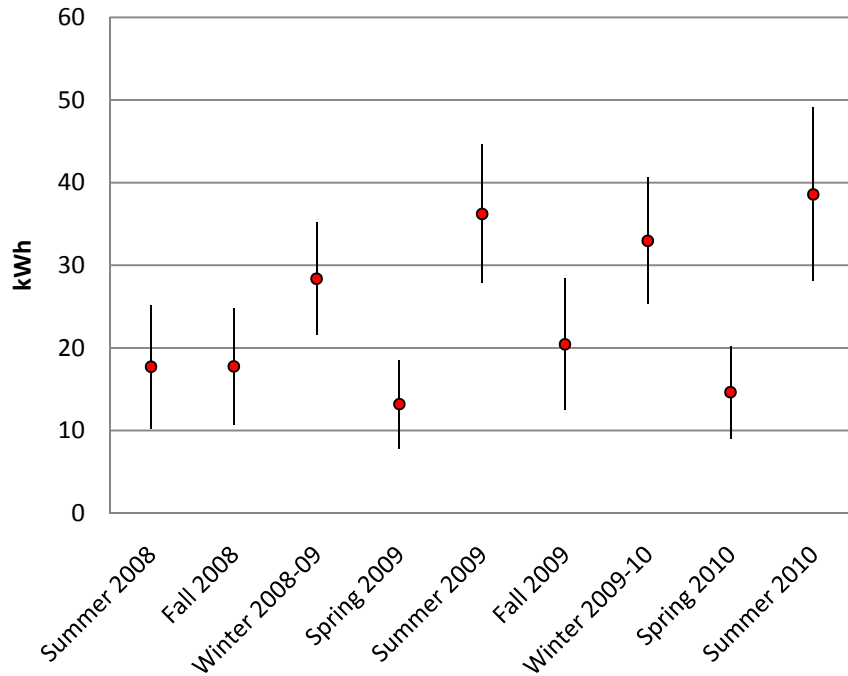


**Program Savings: Estimated Mean Percent Savings with 95% Confidence Intervals**

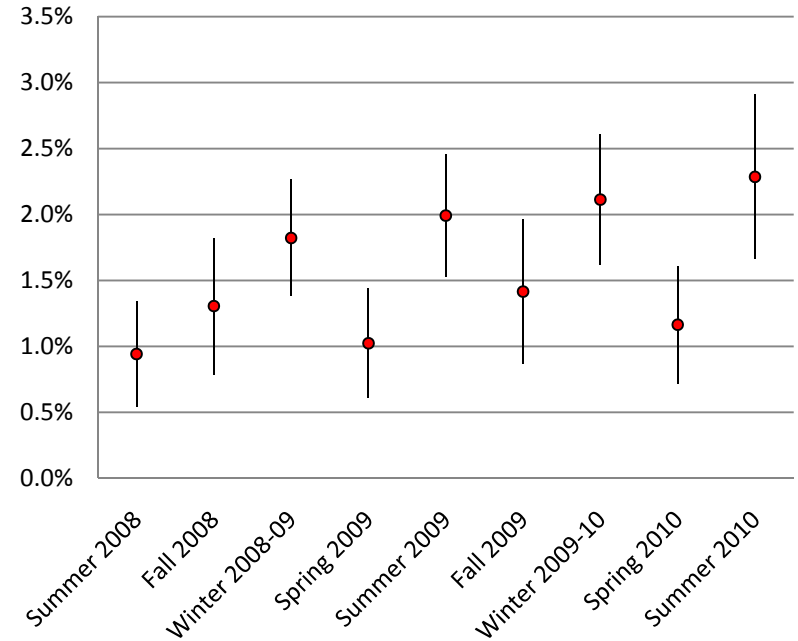


# DID Analysis III: Seasonal Savings, Low Consumers

**Program Savings: Estimated Mean Savings with 95% Confidence Intervals**



**Program Savings: Estimated Mean Percent Savings with 95% Confidence Intervals**



# Fixed Effects Regression Analysis I

- DID analysis as a fixed effects regression equation:

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t + \varepsilon_{kt}$$

- Expanding the fixed effects regression equation to include heating and cooling degree days:

$$\begin{aligned} ADU_{kt} = & \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t \\ & + \beta_0 HDDd_t + \beta_1 HDDd_t \cdot Treatment_k + \beta_2 HDDd_t \cdot Post_t + \beta_3 HDDd_t \cdot Treatment_k \cdot Post_t \\ & + \gamma_0 CDDd_t + \gamma_1 CDDd_t \cdot Treatment_k + \gamma_2 CDDd_t \cdot Post_t + \gamma_3 CDDd_t \cdot Treatment_k \cdot Post_t + \varepsilon_{kt} \end{aligned}$$

# Fixed Effects Regression Analysis II

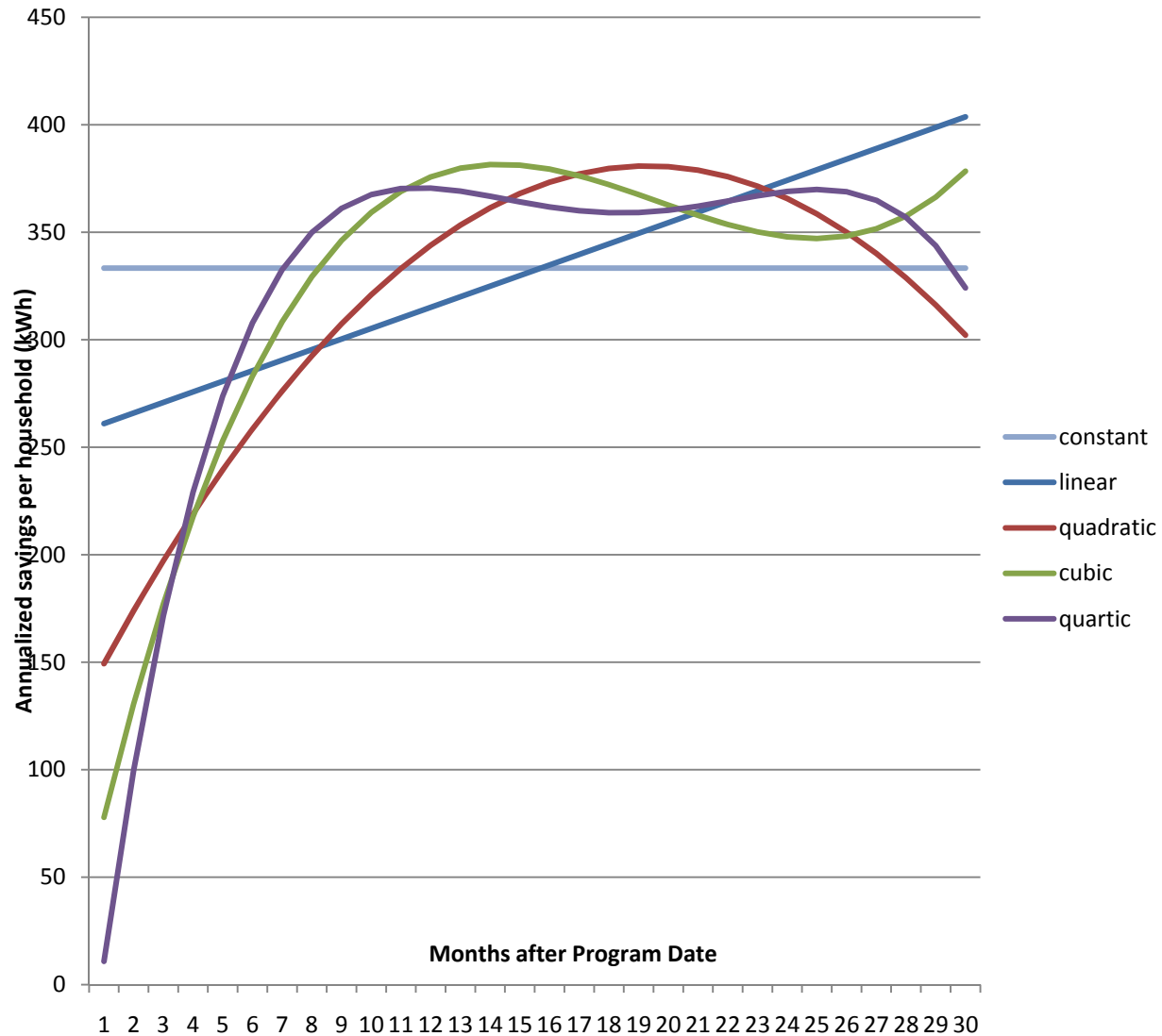
- Expanding the fixed effects regression equation further to include polynomial trends:

$$\begin{aligned}ADU_{kt} = & \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t \\ & + \beta_0 HDDd_t + \beta_1 HDDd_t \cdot Treatment_k + \beta_2 HDDd_t \cdot Post_t + \beta_3 HDDd_t \cdot Treatment_k \cdot Post_t \\ & + \gamma_0 CDDd_t + \gamma_1 CDDd_t \cdot Treatment_k + \gamma_2 CDDd_t \cdot Post_t + \gamma_3 CDDd_t \cdot Treatment_k \cdot Post_t \\ & + \lambda_0 PostTrend_t + \lambda_1 PostTrend_t^2 + \lambda_2 Treatment_k \cdot PostTrend_t + \lambda_3 Treatment_k \cdot PostTrend_t^2 + \varepsilon_k\end{aligned}$$

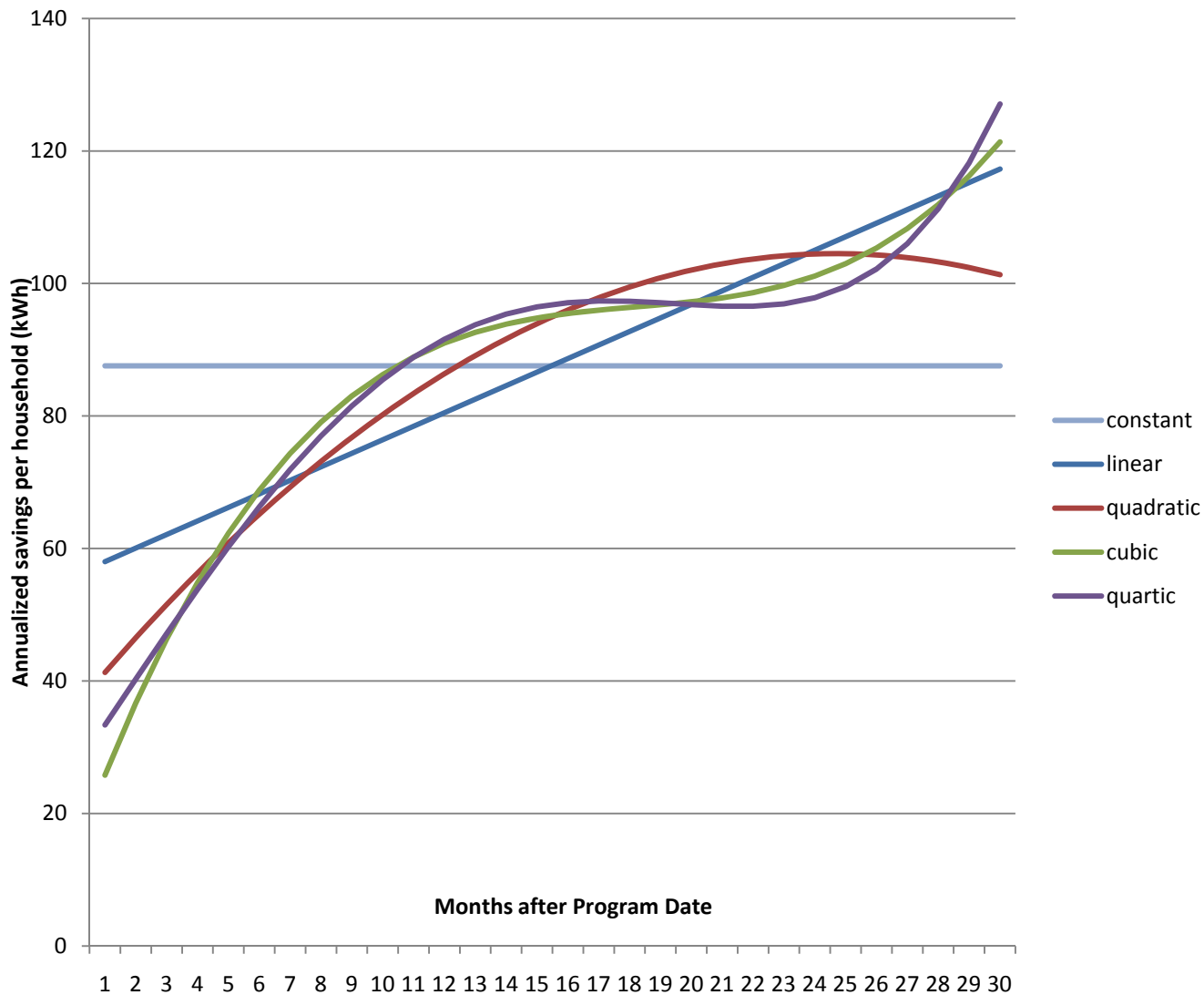
$$\dots + \lambda_0 PostTrend_t + \lambda_1 PostTrend_t^2 +$$

$$\lambda_2 Treatment_k \cdot PostTrend_t + \lambda_3 Treatment_k \cdot PostTrend_t^2 \dots$$

# Polynomial Treatment Trend Results: Monthly Reports



# Polynomial Treatment Trend Results: Quarterly Reports



Why the difference between Monthly and Quarterly households?

There are methods to examine this question...

# Results Summary

- Program savings have been higher in Year 2 than in Year 1
- For high consumption (monthly) households, savings after year 1 have flattened and have remained fairly steady **in percentage terms** for the past year
- For low consumption (quarterly) households, savings continue to rise in both absolute and percentage terms.



# Thanks!

- Thanks to OPOWER and SMUD for the opportunity to evaluate the program...
- ...Thanks to BECC organizers for the opportunity to present this work...and to Kathy Kuntz for moderating...
- ...And thank you for listening!