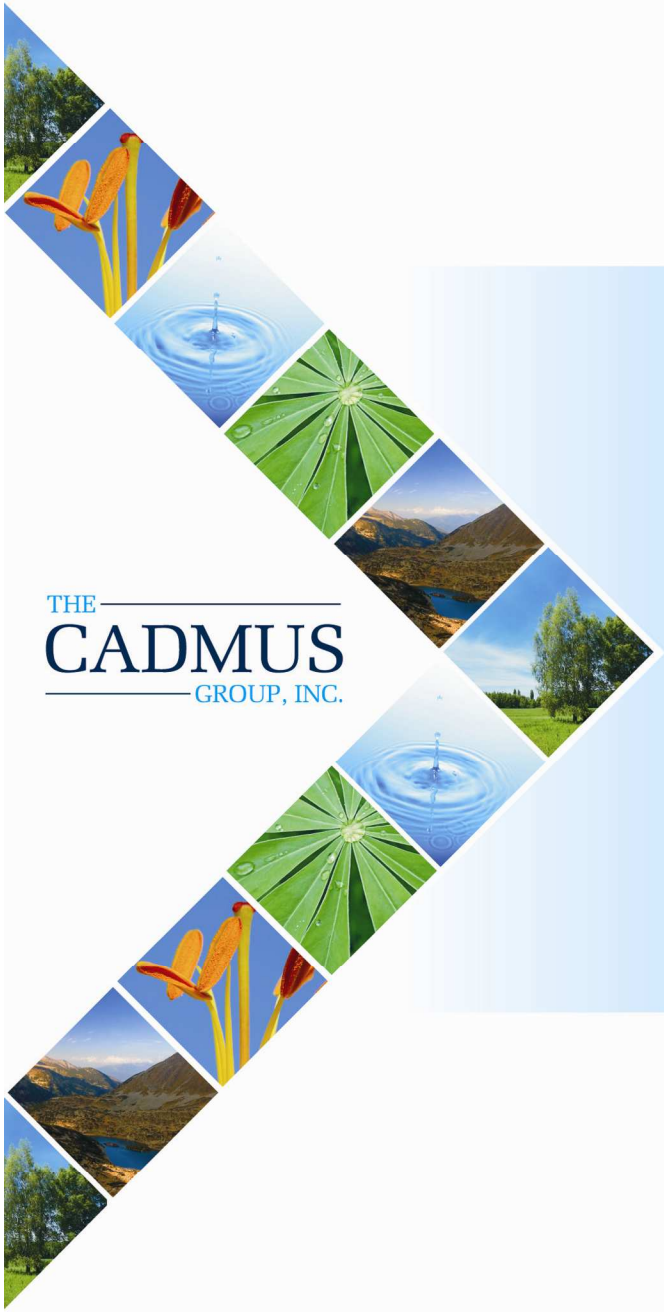

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The View from the Top: Using Macro-Economic Models to Measure Savings in California

IEPEC, Rome
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Outline

- Background
- Study objectives
  - California policy applications
- Literature review
- Data and methods
- Preliminary findings
- Next steps

Background

- Evaluations of utility-sponsored programs have largely relied on bottom-up (B-U) approaches
- Savings are estimated at the measure and program level and aggregated to portfolio
- Potential problems, especially for large portfolios:
  - Technical measure interactions
  - Double-counting savings
  - Upstream programs
  - Rebound effect
  - Self-selection and free-ridership
- Early discrete choice studies showed programs saved less than reported is evaluations
- B-U approaches are expensive to implement

The Top-Down View

- Different focus:
  - Change is aggregate consumption, rather than verification of measure and program savings
  - Market-wide impacts
- Better alignment with public policy objectives:
  - Integrated resource planning
  - Resource adequacy
  - Environmental objectives and GHG reduction targets
- Different methods
  - Macro-economic models
  - Energy use or intensity as the unit of analysis
- Can be relatively inexpensive to implement
- Potential limitations:
  - Attribution of savings
  - Effects of codes and standards

Bottom-Up or Top-Down

Approach	Bottom-Up	Top-Down
Unit of Analysis	Measure Participant Program	Aggregate consumption indicators
Method/Data	Engineering Accounting Statistical comparison	Macro-economic demand models
Purpose	Verification (installation, performance, compliance) Prudence audit QA/QC	Policy design System planning Environmental policy

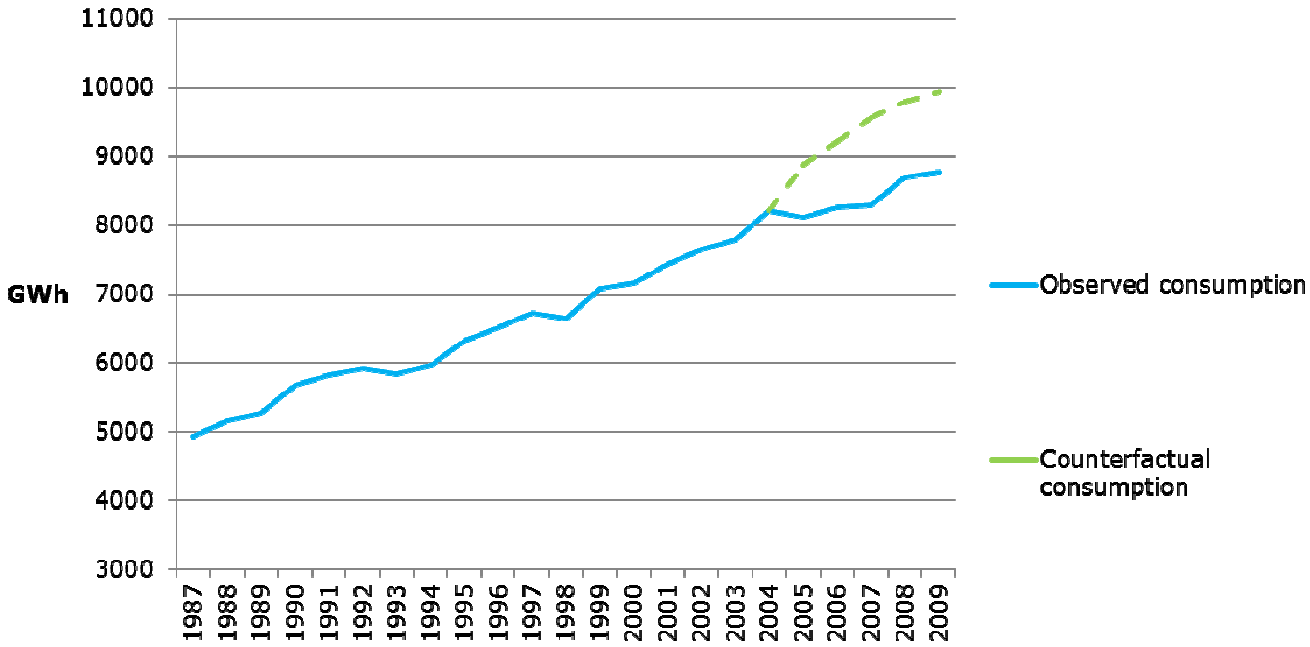
The Basic T-D Approach

- Data:
  - Macro-level, panel data (sector, utility, area) on:
    - Energy-use indicators e_{it} measuring use or intensity
    - Energy use drivers (price, population, income, GDP, etc.)
    - Weather
    - Energy-efficiency activity (investment, savings)
- Method:
  - Energy savings estimated in a double- or semi-log dynamic demand regression:

$$E_{it} = f(\text{Fixed Effect}_i, E_{it-1}, \text{Energy Price}_{it}, \text{Economic Activity}_{it}, \text{Energy Codes and Standards}_{it}, \text{EE Activity}_{it})$$

  - E_{it-1} captures fixed investments and partial adjustment of demand to energy price changes

Top-Down Estimation Method



Study Objectives

- Applicability of T-D evaluation to California energy efficiency policy objectives
- Determination of market gross savings:
  - Utility programs
  - Codes and standards
  - Naturally occurring adoption
- Measuring progress towards GHG reduction goals
- Long term forecasts of energy savings

Study Elements

- Literature review: relevant theory, analytic methods, and results from T-D studies
- Attribution of savings for California's investor-owned utilities (IUOs)
  - Pacific Gas and Electric
  - Southern California Edison
  - San Diego Gas and Electric
- Two parallel study tracks using data at different levels of aggregation:
  - Census tract and ZIP Code (Demand Research, LLC.)
  - Utility/County (The Cadmus Group)
- Work plan for implementing T-D approach in California

Literature Review

- Eight T-D savings evaluations (1996-2011)
- Estimated savings attributable to utility programs, market transformation or building codes in the U.S., Canada, or California
- Similar research designs and data
  - Panel data on annual consumption and utility EE expenditures at utility or state from EIA
  - Panel regression methods to estimate savings
- Different results and conclusions

Summary of Findings

- Despite similar research designs and data sources, estimates of utility program savings and cost effectiveness vary widely
  - All retail sectors (Loughran and Kulick, 2004 (20-25%); Aufhammer, Blumstein, and Fowlie, 2008 (100%); Rivers and Jaccard, 2011 (0%)
  - Commercial sector: Parfomak and Lave 1996 (100% realization rate) and Horowitz 2004 (54%)
- Estimates of utility savings are imprecise
- Questions about reliability of EIA consumption and energy efficiency expenditure data

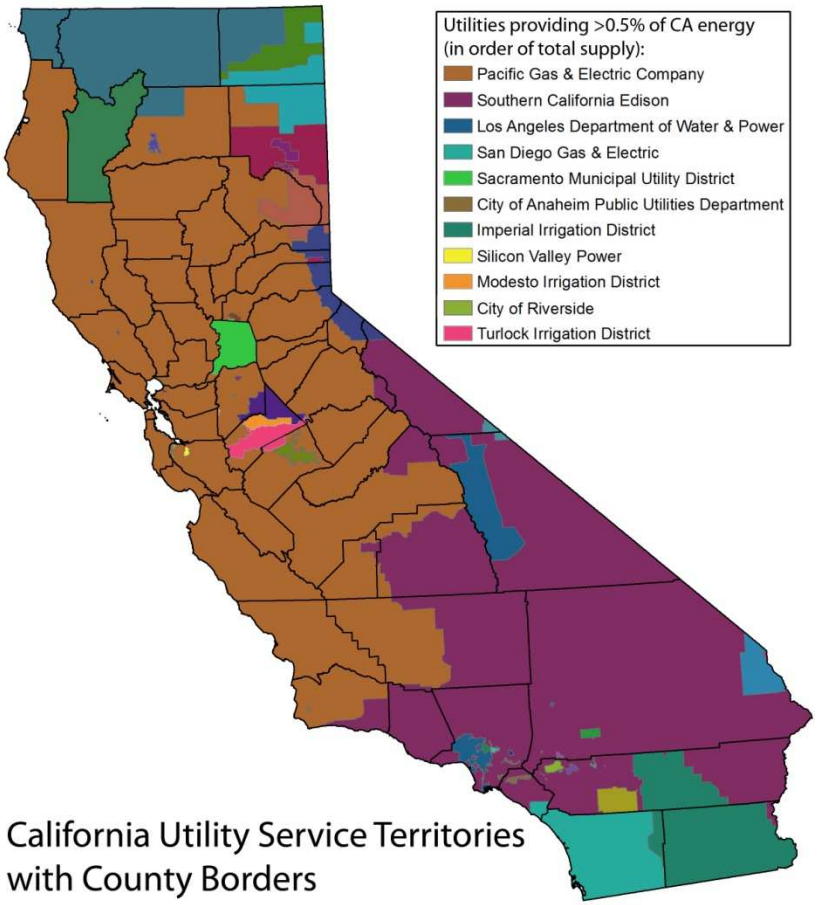
Study Design

- Estimate savings at aggregate and sector levels for each IOU
- Unit of analysis would be utility service territory and/or county
  - 75 EDCs in CA in 2010, but 5 utilities (PG&E, SCE, LADWP, SDG&E, and SMUD) accounted for 82 percent of retail sales
  - Sample could be enlarged to include other large municipal utilities (Santa Clara, Anaheim, Riverside)
- Estimated model with 2006-2010 data

Data and Modeling Options

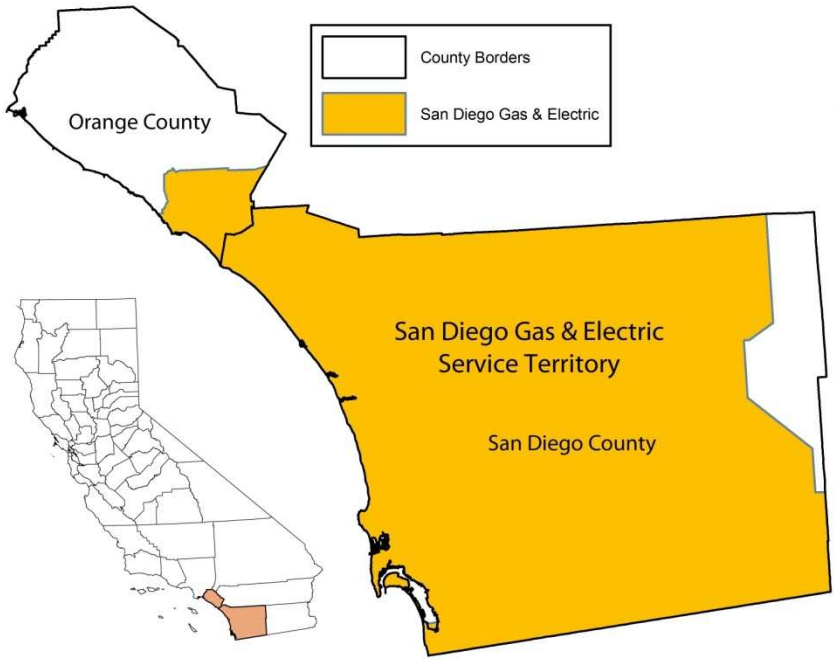
- Availability of data is the main constraint
- Primary data elements (time-series, cross-sectional):
  - Consumption, DSM expenditures, Energy prices, Demographics, Macro-economic data, Weather, Equipment saturations, Codes and standards
- Level of analysis:
  - State
  - Utility – IOUs and municipals
  - Sector – Residential, Commercial, Industrial, Agriculture
  - County - 58
  - ZIP Code – 6,162
- Converting data from one level to another can introduce bias and increase measurement error

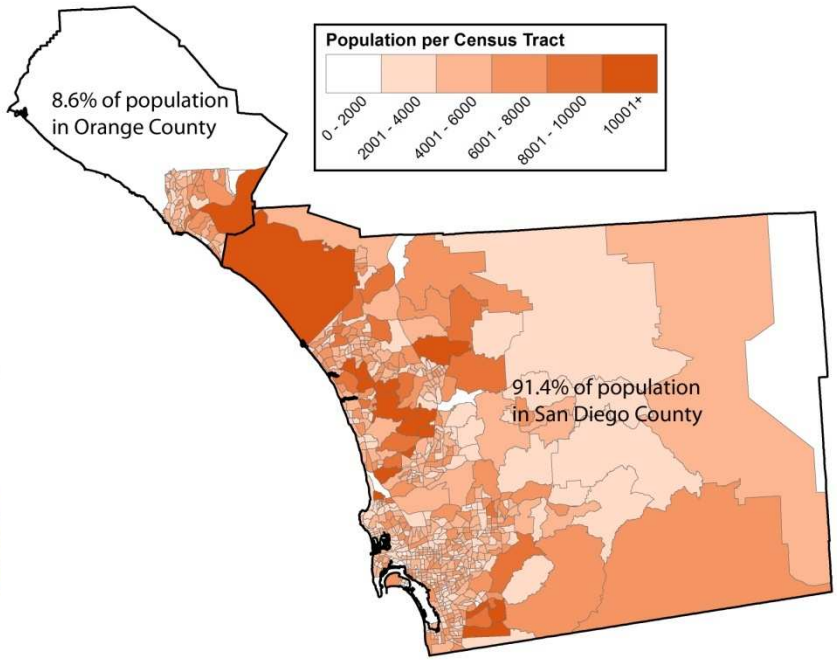
Mapping Counties to Utility



California Utility Service Territories
with County Borders

Mapping Counties to Utility





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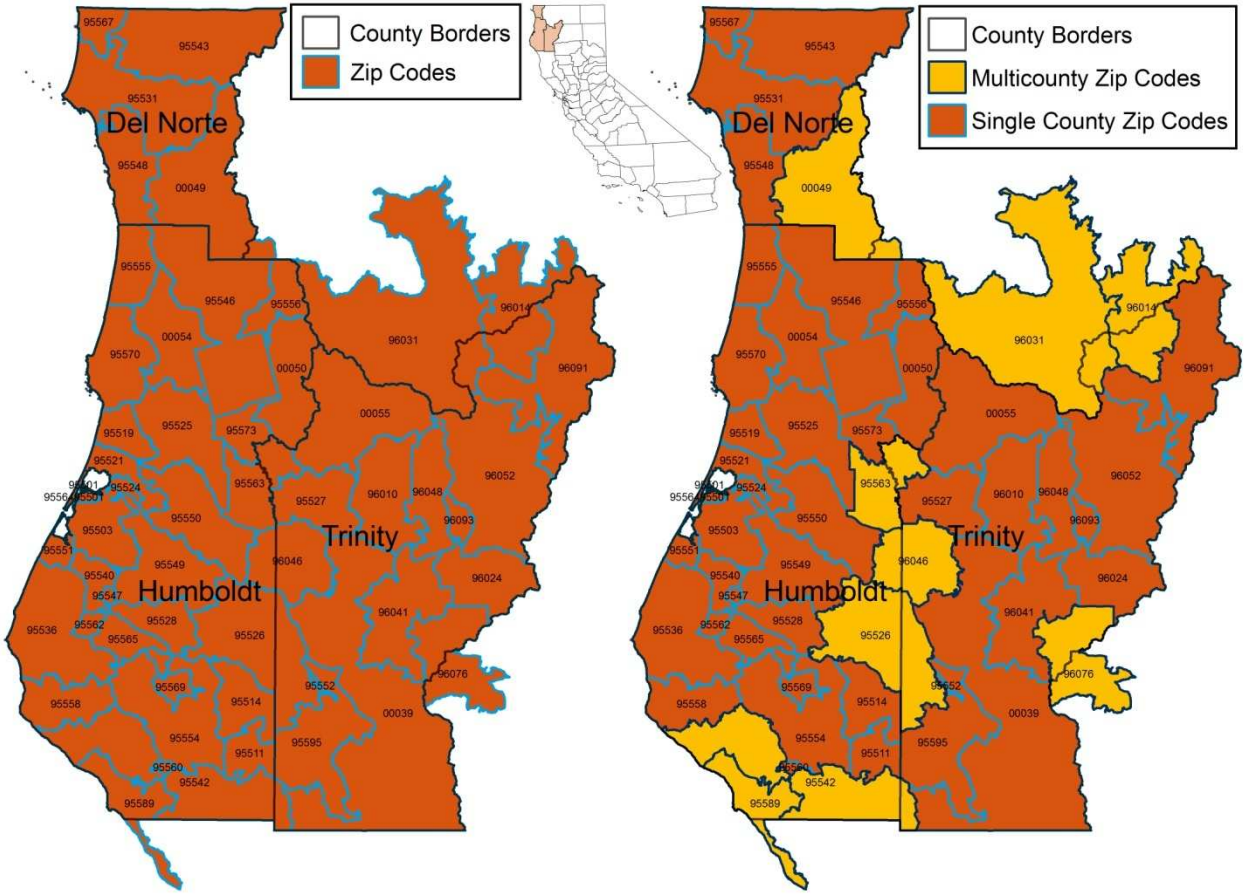
Mapping ZIP Codes to County



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Preliminary Results

- A variant of the general model was used to estimate aggregate savings for three IOUs between 2006 and 2010
- Predicted IOU savings:
  - PG&E: 1,081 GWh or 1.2% of consumption in 2006, increasing to over 3% of consumption in 2010, as expenditures more than doubled
  - SCE: 1.2% for 2006, decreasing to about 0.5% in 2008, and rising to 2.3% in 2010
  - SDG&E: 1.2% of consumption in 2006, reaching a maximum of 3.8% in 2008.

Aggregate Results

- For all IOUs: 1.2% in 2006 and 2.7% in 2010.
- The model performed better at predicting aggregate savings over multiple years
- Annual savings were slightly under-or overestimated
- Savings estimates were more precise for PG&E and less so for SCE and SDG&E
- The model under-predicted SCE's and over-predicted SDG&E's savings
- Over time and across the three utilities, the model performed relatively well:
  - Program savings between 2006 and 2010 were 17,516 GWh, approximately 7% lower than what was reported by the utilities for the period

Next Steps

- Estimate aggregate models at the county level
- Estimate models for sectors:
  - Residential
  - Commercial
  - Industrial
  - Agricultural
- Develop and estimate models for natural gas
- Prepare final report – will be posted on CALMAC

Questions/Comments?

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