



Preliminary Findings Memo

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Executive Summary

The California Public Utilities Commission (CPUC) has expressed interest in potential policy applications of macro-consumption models to estimate energy savings. In contrast to micro-analyses of site energy use, commonly used in energy-efficiency program evaluations, macro-consumption studies use aggregate (e.g., utility service area, county, census block) energy use and energy-use driver (e.g., income, prices) data to measure savings. Macro-consumption models offer a number of potential policy applications, including:

- Estimating savings from utility energy-efficiency programs, building codes or appliance standards, and naturally occurring adoption of energy efficiency measures;
- Tracking reductions in greenhouse gases from state policies and utility energy efficiency programs; and
- Incorporating energy efficiency savings in load forecasts.

In spring 2011, CPUC selected Cadmus to participate in its Macro Consumption Pilot Studies project, which involved two parallel macro-consumption studies. The studies sought to:

- Investigate the viability of using macro-consumption approaches to measure reductions in energy consumption from energy-efficiency programs and policies in California;
- Investigate the potential for developing robust methods for measuring and tracking carbon emission reductions resulting from energy-efficiency requirements of the state Assembly Bill 32; and
- Assess the applicability of MCMs to forecasting future energy savings from energy-efficiency programs and policies.¹

For the project's first phase, Cadmus critically reviewed the existing literature; assessed the availability of data for and likely success of a macro-consumption study in California; and developed a macro-consumption model research proposal. Much of that work leading up to data collection and preparation was reported in previous CPUC public workshops and in technical memorandums, publicly available at the CPUC's Website.

For the study's second phase, Cadmus followed the tasks described in its research proposal: collected study data; developed a large panel database; and developed and estimated macro-consumption models.

This memo describes the results from the data collection, database development, and initial modeling efforts, and reports preliminary electricity savings estimates derived from the models.² Specifically, Cadmus reports annual electricity savings from utility energy efficiency programs

¹ California Public Utilities Commission. October 28, 2010. *Decision on Evaluation, Measurement, and Verification of California Energy Efficiency Programs*. Decision 10-10-033.

² The pilot draft report will include the results of the gas consumption analysis.

between 2008 and 2010 and electricity savings between 2002 and 2010 from the 2001 update to California's Title 24 building codes.

Data collection included energy-use and energy-use driver data for 56 California electric utilities and six gas utilities, including information about energy consumption, population, income, gas and electricity prices, new construction, and weather.

The availability and quality of utility energy-efficiency program expenditures data emerged as the largest obstacle in developing reliable savings estimates. Analysis of expenditures series showed significant discrepancies between sources and suggested the presence of reporting errors in some sources. Recent expenditures data from the California Municipal Utility Association (CMUA) and California's Energy Efficiency Groupware Application (EEGA) appear to be of the highest quality. We provide evidence suggesting significant measurement errors may occur in the Energy Information Administration (EIA) expenditures data.

Using data on California investor- and publicly-owned utilities between 1997 and 2010, Cadmus estimated panel regression models of electricity-use intensity. We modeled:

- Utility consumption per capita;
- Residential sector consumption per housing unit; and
- Nonresidential consumption per square foot of floor space.

Analysis of utility consumption per capita indicated significant electricity savings from utility energy-efficiency programs and building codes. Analysis of the largest utilities' consumption (PG&E, SDG&E, and SCE) showed a \$1.00 increase in current energy-efficiency program expenditures per capita reduced consumption per capita by approximately 0.05%; an equal increase in two-year lagged expenditures reduced energy consumption per capita by 0.2% per year.

Bases on historical expenditures, these results imply total savings from current and past (previous three years) investor-owned utility (IOU) energy-efficiency program expenditures increased from 7,830 GWhs in 2008 to 10,321 GWhs in 2010, reflecting a doubling of energy-efficiency expenditures over this period. Estimated electricity consumption would have been 3.9% higher in 2008 and 5.5% higher in 2010 without the IOU energy-efficiency programs.

The savings estimates imply costs of saved energy from current expenditures (first year savings) of approximately \$0.30/kWh. Between 2008 and 2010, the cost of saved energy from current and past (previous three years) energy-efficiency program spending was estimated to be in the range of \$0.04–\$0.08/kWh, a somewhat higher estimate than costs of saved energy reported in other studies. We hypothesize our results may reflect California's lead in energy efficiency, and the exhaustion of low-cost savings opportunities in the IOU territories. We estimate the cost of first-year savings in other California utility programs at approximately \$0.04/kWh, a finding more consistent with those of other studies.

Cadmus had less success detecting savings from utility energy-efficiency programs in the residential and nonresidential sectors. In general, the coefficients on energy-efficiency

expenditures did not statistically differ from zero. We believe this may reflect the difficulty of disaggregating expenditures by sector and errors in measurement of energy-efficiency expenditures in the residential and nonresidential sectors.

Cadmus also found that the 2001 update to California's Title 24 building code resulted in significant energy savings. Energy savings in the IOU service territories from the 2001 update increased from 2,700 GWhs in 2002 to 5,200 GWhs in 2008. These savings represented approximately 2.0-2.7% of annual electricity consumption.

Using energy-efficiency program expenditures and building codes as examples, the results of this study demonstrate the potential policy applications of macro-consumption models. Cadmus was able to detect savings from utility energy efficiency programs and building codes, despite using a panel with a small number of utilities and a relatively short time series. One limitation of the study was savings from energy-efficiency programs were not estimated precisely. Future collection of additional data and continued refinement of the models would improve the precision of savings estimates and reduce uncertainty.

Introduction

In the second phase of CPUC's Macro Consumption Pilot Studies project, Cadmus developed a panel database of consumption, prices, incomes, and other economic and demographic variables for California's electric utilities and gas utilities, between 1990 and 2010.³ In addition, Cadmus completed an initial round of modeling and estimation of utility service area electricity consumption intensities. We modeled utility electricity consumption per capita, residential sector electricity consumption per housing unit, and nonresidential sector electricity consumption per square foot of floor space. This memo describes the results of these recent efforts, including preliminary estimates of electricity savings from utility energy efficiency program and building codes derived from the models.

Database Development

As described in our technical memorandum, Cadmus collected time series data on electricity and gas consumption and variables affecting consumption (such as income, population, new construction, and energy-efficiency expenditures) for the California utilities and counties. Over the previous six months, Cadmus collected and analyzed individual series and merged them into a single database.

This model database covers 1990–2010, and includes data for: 56 electric and 6 natural gas investor-owned, public, and rural cooperative utilities; and 59 California counties. Utility sector and county data include:

³ Cadmus is still working on developing and estimating the gas consumption models. The pilot draft report will include the results of the gas consumption analysis.