Precourt Energy Efficiency Center

Dr. Henry Kelly
U.S. Department of Energy

Mr. Richard Duke
Associate Director for Energy and Climate Change
White House Council on Environmental Quality

July 25, 2013

Re: Influence of Efficiency Policy on California's Electricity Consumption

Dear Dr. Kelly and Mr. Duke,

Thank you for inquiring about the influence energy efficiency policy has had on electricity consumption in California. A recent working paper, written by Professor Arik Levinson,[1] and articles in The Wall Street Journal and in Forbes[2] have made the point – initially made public by Dr. Anant Sudarshan and me – that the large observed differences between California per capita electricity use and overall US per capita electricity use can be partially explained by demographic, climate, and economic differences. The empirical evidence supports the conclusion that the majority -- but far less than all -- of the per capita residential electricity use differential can be explained by demographic, climate, and economic differences.

But The Wall Street Journal and Forbes articles have gone further and asserted that "energy efficiency standards are a very poor way of targeting the problems associated with energy use." This conclusion appears to be based on Prof. Levinson's working paper and by interviews with him. That conclusion is definitely not supported by the existing research and not supported by the observation that the majority of the electricity use differentials between California and the US can be explained by demographic, climate, and industrial structure differences.

I have analyzed California's energy efficiency policies for many years, and there is strong evidence that these policies do provide significant benefits to the state and do offer valuable lessons for other jurisdictions seeking to provide economic benefits while cutting pollution, including greenhouse gas emissions.

Efficiency Policy is One of Several Important Factors Leading to California's Lower Consumption

[1] Arik Levinson, "California Energy Efficiency: Lessons for the Rest of the World, or Not?", NBER Working Paper No. 19123, June 2013
[2] *The Wall Street Journal*, June 18, 2013. "Did Regulation Cause Drop in California Energy Consumption?"; *Forbes*, 7/10/2013 "Don't Thank Stringent Regulations For California's Reduced Electricity Use"

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The evidence is clear that energy efficiency policy is only one of many important contributors to California's relatively flat per capita electricity consumption over the past forty years (which diverged significantly from the rest of the nation's per capita consumption, which increased approximately 50% during that time frame). The fact that efficiency is not the only cause of the difference between California and the rest of the nation's per capita consumption trends should come as no surprise, since electricity consumption is influenced by many demographic, climate, and industrial structure factors.

My colleague, Dr. Anant Sudarshan, and I have examined the causes of the state's divergent path in detail. Our initial empirical work, and subsequent more complete work published by Dr. Sudarshan, analyzed the various non-energy-policy factors that explain over half the difference in per capita consumption between California and the rest of the nation. Importantly, we found that reductions in per capita consumption *not explained by other factors* are roughly consistent in size with the California Energy Commission's bottom-up estimates of energy savings resulting from state efficiency policies.[3] I expand on this point later in this letter.

Analysis of Prof. Levinson's Working Paper

Turning to the Levinson paper, the first half of the paper uses weak methodology and finds little impact of California energy efficiency policy. The second half of the paper uses a more rigorous and more valid methodology and finds a significant impact of California Energy policy, an impact consistent with the previous published literature. However, he words his conclusion very strongly, citing the weakest part of the empirical results rather than the methodologically more sound empirical results.

I note that Prof. Levinson shows in his Figure 1 that California apparent savings exist across every sector of the economy and that these savings include both electric and non-electric energy sources. Prof. Levinson's analysis focuses almost exclusively on the residential sector electricity use and consequently any conclusions about energy efficiency policy from his paper could apply only to residential sector electricity use programs.

It makes very little sense for him to study the residential sector and to ignore non-electric energy if his goal is to assess "California Energy Efficiency: Lessons for the Rest of the World, or Not?" The majority of residential heating needs in California are filled by natural gas, as are a large share of cooking energy requirements. California's Title 24 and California's HVAC efficiency standards have reduced space heating and cooling needs. Therefore it is necessary to look not only at electricity but also at natural gas. Dr. Sudarshan does this in the 2013 *Energy Economics* paper and finds that an average difference of over 40% remains between households inside California using natural gas for heating and those outside using the same fuel for heating (controlling for climate and other household characteristics). This effect is strongest in homes with high space heating needs, precisely the settings where efficiency and building standards might have the most impact. Inexplicably, Prof. Levinson seems to ignore this impact of California energy efficiency policy, at least in stating his conclusions.

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[3] Anant Sudarshan and James Sweeney, "Deconstructing the Rosenfeld Curve," June 2008, http://peec.stanford.edu/library
Anant Sudarshan and James Sweeney. 2008. "Deconstructing the Rosenfeld Curve: Understanding California's low per capita electricity consumption." Proceedings of the 28th USAEE/IAEE North American Conference. December 3-5, 2008.
Anant Sudarshan, "Deconstructing the Rosenfeld Curve: Why is California's Residential Electricity Consumption So Low?" *Energy Economics* 2013.

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Prof. Levinson carries out two forms of analysis of residential per-capita electricity use. In the first half of the paper, he draws attention to four variables – population shifts, household size, income, and climate variables – to argue that these factors explain most of the residential electricity difference between California and the rest of the country between 1960 and today. Prof. Levinson's analysis appears to show that 95% of the difference between the California and the US per capita residential electricity use can be explained by demographic and climate differences, appearing to leave at most 5% as possible impacts of California energy efficiency policies. Our previous research has shown these factors are important, but that their cumulative effect is substantially smaller than his estimate.

The analysis in the first half of the Levinson paper cannot support quantitative statements on how much these four factors taken together matter. Adjusting for each factor separately and adding them together, as Prof. Levinson has done in the first part of his paper, systematically overestimates their importance. This overestimation comes about because of the strong empirical correlations between these variables. Prof. Levinson acknowledges this issue in passing, but the popular press articles and his final conclusion appear to have missed that fundamental issue. A multivariate regression is a minimal necessary requirement to correct for this type of issue.

In addition, there are difficulties with Professor Levinson's individual estimates. He has over-estimated the impact of migration because he included the shift in the United States toward warmer regions but failed to include the similar migration within California toward the warmer regions: Southern California and the Central Valley.

Prof. Levinson provides a misleading statement of his estimated impact of household size on differences in per-capita electricity use, when he states "Together, the predicted effects of the long-term changes in household and home characteristics account for … 61 percent of California's apparent residential electricity savings." But "apparent savings" is not the difference between California and the US per capita electricity use. It is the difference between California's actual electricity use and the use Prof. Levinson projects it should have been, had it grown like other states. This is about one-half of the actual differential. And in his calculation, Prof. Levinson uses the differential change in household size during the entire time interval from 1960 to 2009 -- 0.6 people per household. But that entire differential change over 49 years is not the appropriate variable to explain the actual year 2009 differential in electricity use. Using the 2009 actual difference in household sizes (3.03 people per household in California and 2.67 people per household in other states) with his Table 7 regression coefficient on household size, implies that household size differences in 2009 should account for a difference of 1.53 million BTU per household member. The total difference in 2009 is 8.126 million BTU per household member. Thus I interpret his regression as suggesting that household size differences account for 23% of the actual difference in 2009 residential per-capita electricity consumption.

In the second half of the paper, Prof. Levinson draws upon micro-data from the Residential Electricity Consumption Surveys to carry out a multivariate regression analysis of household energy use (two different Oaxaca-Blinder decompositions based on data from year 2009 only). This method does not suffer from the adding-up difficulty in the first half of his paper and is likely to be better at resolving some of the problems listed above.

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Prof. Levinson's regression is a less detailed version of the paper previously published by Dr. Sudarshan.[4] Dr. Sudarshan's paper accounts for both electric and non-electric end uses, appliance holdings and heterogeneity in household types, issues missing in the Levinson analysis. Surprisingly, Prof. Levinson neglects to incorporate electricity prices, even though relatively high California electricity prices are important variables affecting consumption and are influenced by California policies. Both Dr. Sudarshan and Prof. Levinson use Energy Information Administration, Residential Energy Consumption survey data from the year 2009.

One set of Prof. Levinson's equations, estimated without his 26 regional fixed effects for other states, suggests that the observable differences explain 61% of the per capita electricity use difference and that up to 39% of the residential per capita use differentials could be the result of California policies. The second set of equations, with 26 regional dummies for non-California regions (his fixed effects), suggest that the observable differences explain 88% of the per capita electricity use difference and that only up to 12% of the residential per capita use differentials could be the result of California policies. Levinson quotes his results in terms of the second equations, but realistically he cannot tell whether the regional fixed effects also include the absence of California policies in these other states and the differences in policies among the various regions. Thus while he seems to prefer his second set of estimates, this second set may not reveal some of the policy impacts. These equations, taken alone, suggest that California polices – not including electricity price effects – could have accounted for up to between 12% and 39% of the differential per capita energy use.

The 12% figure is very similar to the results reported in Sudarshan's 2013 *Energy Economics* paper. Dr. Sudarshan estimates that 13% of the differential could be the result of policy impacts other than electricity price and that, in addition, 5% of the differential could be accounted for by price effects, for a total of 18% of the differential.

These estimates match remarkably well with California Energy Commission official bottom-up estimates of savings. The attached figure is taken from the Sudarshan 2013 paper. The bottom line is the actual California residential per-capita electricity use; the top line is the actual US residential per-capita electricity use. The blue line is the Sudarshan counterfactual estimate of California per capita use absent demographic and climate differentials and price differentials. The red line (third from top) is the California Energy Commission estimate of what electricity consumption would have been absent policy and price differentials. Thus taking into account demographic and climate effects, as well as price effects, the Sudarshan estimate and the California Energy Commission bottom-up estimate of its policy impacts give almost the same counterfactual estimates of per-capita residential electricity use.

There is Strong Evidence that California's Efficiency Policies Provide Large Benefits

Our finding that a substantial part (although not the majority) of the difference between California and US per capita electricity use could be due to efficiency policies is consistent with California's policy process. The California Energy Commission and the Public Utilities Commission strive within the California efficiency regulatory framework to achieve energy savings *beyond* what would have happened anyway. For example, the California Energy Commission's efficiency standards for new buildings and appliances are required to be cost-effective based on the difference in energy consumption between the higher efficiency level and

[4] Anant Sudarshan, "Deconstructing the Rosenfeld Curve: Why is California's Residential Electricity Consumption So Low?" *Energy Economics* 2013.

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standard market practice. The utility energy efficiency programs overseen by the California Public Utilities Commission are similarly required to be cost-effective based solely on the *net* savings beyond those that would have happened in the absence of the programs.

In addition, California efficiency policies have impacted electricity use in other states by providing models that have been integrated into national energy efficiency policies. Such impacts cannot be estimated from observed differences between California and US electricity use because these policies have reduced electricity use throughout the US as well as in California. For example, many appliance efficiency standards, e.g. refrigerator efficiency standards, have been adopted as national policy after being shown in California to be effective.

The lessons from California's experience for other jurisdictions to me are clear:

- Would similar energy efficiency policies in other jurisdictions guarantee flat per capita electricity consumption? Absolutely not. There are many factors influencing consumption in addition to energy efficiency. However, energy efficiency policies do reduce energy consumption below business as usual levels.
- Would similar energy efficiency policies provide economic benefits and reduce pollution? Yes. There is strong evidence that California's energy efficiency policies work, and have saved Californians billions of dollars while curbing pollution.

Please feel free to contact me if you would like to discuss these important issues further.

Sincerely,

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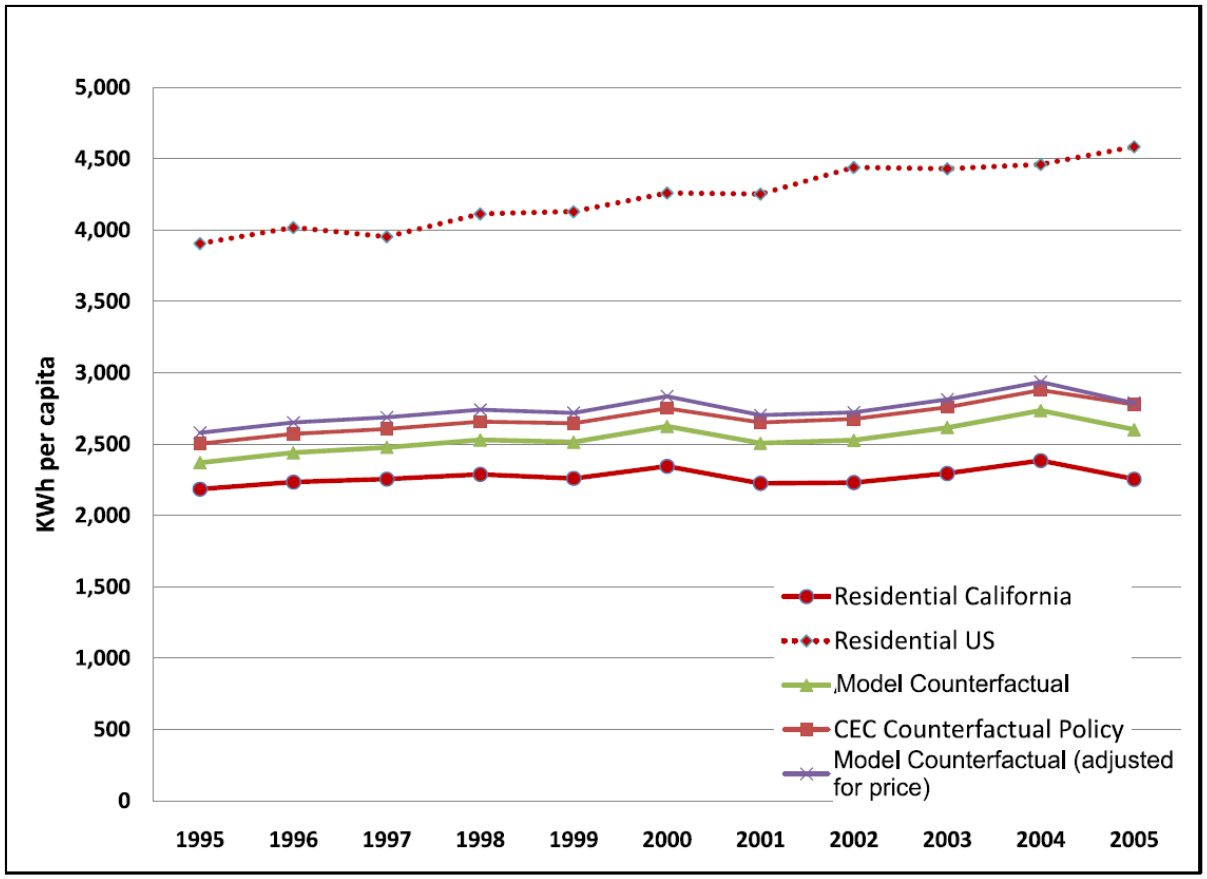

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