STATEMENT OF CATHERINE WOLFRAM

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SELECT COMMITTEE ON CALIFORNIA'S CLEAN ENERGY ECONOMY

ENERGY EFFICIENCY OF EXISTING BUILDINGS

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Thank you, Assemblymember Quirk, and thanks to the rest of the committee.

I'm Professor Catherine Wolfram, the Cora Jane Flood Professor of Business Administration at the Haas School of Business and the Faculty Director of the Energy Institute at Haas. I'm also Faculty Director of the E2e Project, which is a joint venture between the University of California - Berkeley, the Massachusetts Institute of Technology (MIT), and the University of Chicago.

I have been doing research on energy markets for over 20 years, and one of the main areas of focus for me is energy efficiency. I made this choice because every major carbon mitigation strategy out there relies heavily on energy efficiency, so my colleagues and I want to make sure that (a) we're getting what we think we are from energy efficiency programs, and (b) we are doing everything possible to select the best energy efficiency programs, even if that means ending under-performing programs.

I will preview my remarks by saying that we have room to improve on several fronts. This is crucial – we can't keep our heads in the sand and pretend we're addressing climate change when we are actually not.

1. Let me start by noting that energy efficiency is hard to measure. Meters do not run backwards to count kilowatt-hours that were not produced because of an energy efficiency program. What you need to do is establish a baseline, or counterfactual, which describes what would have happened absent the energy efficiency program.

   For example, how much energy would a household have consumed absent a home retrofit? This is difficult because it involves modeling human behavior and decisions that people would have made in a state of the world that you don't observe. For example, you would need to know if the family that got the home retrofit would have turned down the AC afterwards absent the program, or whether they did that because the retrofit made it cheaper to keep the house cool, whether they changed anything else in their house, like got new electronic devices. This is not an easy task.

2. In 81%[1] of US states with significant energy efficiency activities, regulators have basically taken a pass on this difficult task because they use ex-ante engineering estimates to measure the savings from the programs. This means that what happens at the house after a retrofit is generally not taken into consideration. Instead, regulators rely on estimates produced before the fact to decide if a program was successful. Unfortunately, these engineering estimates tend to be quite imperfect when it comes to modeling human behavior.

3. There are viable alternatives to these before-the-fact measurements: Randomized Controlled Trials. My colleagues and I at The E2e Project are dedicated to finding more opportunities to use this methodology and related quasi-experimental approaches to more precisely measure savings from energy efficiency programs.

[1] Kushler, Martin, Seth Nowak, and Patti Witte (2012). "A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs." American Council for an Energy-Efficient Economy Report Number U122 (February).

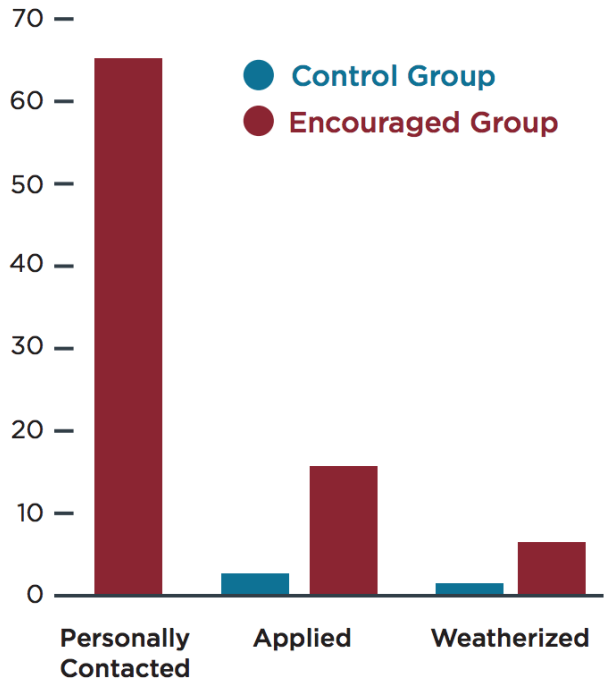
Randomized controlled trials are used widely in medical, social science, and business applications. The FDA requires evidence from an RCT before approving a drug. Companies like Google rely on randomized controlled trials all the time to answer questions about the effectiveness of their ads. There are also several important cases, for example from the medical literature, where results from previous work has been over-turned with a randomized controlled trial, which points out that non experimental results can be misleading and steer policy in the wrong direction.

4. My colleagues and I were able to conduct a randomized controlled trial to measure the energy savings from the Weatherization Assistance Program (WAP) in Michigan. WAP provides energy efficiency retrofits to qualifying low-income homes at no out-of-pocket cost to the household.

I've summarized some of our findings on the handout.

a. First of all, given that WAP is a public program, we used a variant of a randomized controlled trial, the randomized encouragement design. In this design, we encouraged (instead of mandated) a random set of households to enroll in the program. One of the benefits of this approach is that it helps us learn about how to get people involved in the program.

Figure 1 - Energy efficiency is a tough sell, even when it's free.

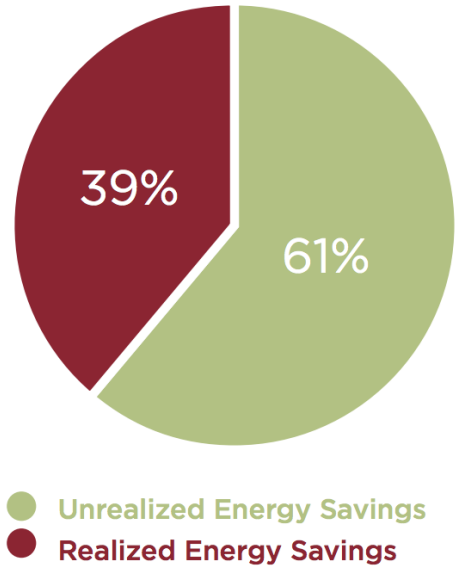


We found that it's very hard – much more difficult than we would have expected – to encourage people to sign up for free home energy retrofits. In our treatment group, we had nearly 9,000 households and made a personal contact with two-thirds of

them. We explained that the program would be free and that we would help them apply. Still, we got fewer than 15% of the people to fill out an application. This could suggest that, though the out-of-pocket costs are zero, there are other perceived costs of participating in the program, like that an unknown contractor hired by the government will come muck around your house, possibly drilling holes in your wall.

b. In terms of energy savings, we also found disappointing results. The program did save households 10-20% on their gas and electricity bills but that was considerably less than the *ex-ante* engineering estimates suggested. As you see on Figure 2, the program saved less than 40% of what it was predicted to save.

Figure 2 - The energy efficiency measures undertaken by households in the study reduced energy consumption by much less than engineering models predicted



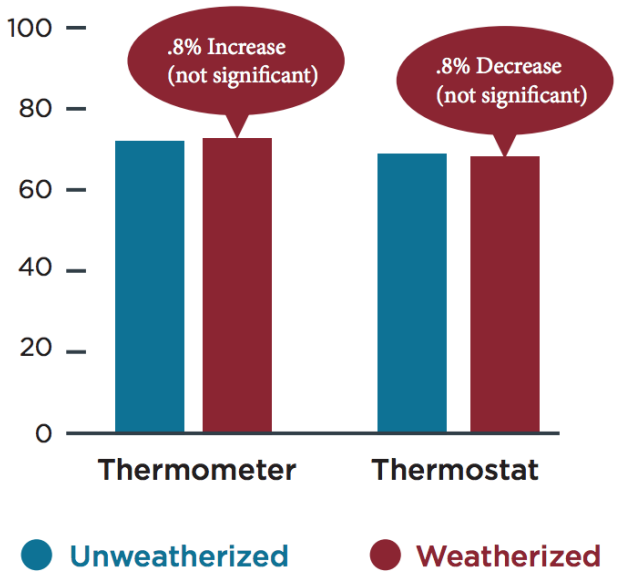
As a result, the government was spending around $5,000 per house (before including any of the administrative costs) to generate about $2,500 in savings. This is not a well-performing program.

c. We also looked for evidence of what's called the rebound effect. This is the idea that people will adjust their indoor temperature after a retrofit. We found no evidence of this. Figure 3 presents results from visits we made to treated and control group households where we measured the indoor temperature and looked at their thermostats. Both weatherized and control group households kept their homes at almost the exact same temperature. So, this particular explanation for why the engineering estimates might be overestimating savings does not turn out to be true.

Our study points to the need to get better engineering estimates and to do more *ex-post* analysis. We need a continuous feedback loop, where we evaluate, refine the program, evaluate it again, and make continuous improvements. Or, we need to get rid of it entirely, if it seems too hard to improve the results. We need to figure out

why the engineering estimates are so far off and if there's a way to make them better.

Figure 3 - We found no evidence of a significant rebound effect



5. Our study is not the only one to find stark differences between experimental results and engineering estimates. An emerging body of evidence suggests that many engineering models are significantly overstating energy savings from energy efficiency programs. Our evaluations of the Weatherization Assistance Program[2] in Michigan or of the Cash for Coolers Program[3] in Mexico are good examples of this. Relevant to home energy retrofits, a CPUC-commissioned study[4] found that retrofits under Energy Upgrade California saved significantly less than forecast.

6. We need to do better. I would like to strongly encourage you to take action on 3 fronts. Members of the Assembly and other law makers can:

    a. Promote the use of scientifically rigorous methods, which use *ex-post* actual data, to evaluate energy efficiency programs. This could be done by passing legislation that requires the implementation of RCTs, for instance.

[2] Fowlie, Greenstone, and Wolfram (2015). Available here.
[3] Davis, Fuchs, and Gertler (2013). Available here.
[4] Calmac CPU0093.01, October 2014 - "Whole House Retrofit Impact Evaluation Evaluation of Energy Upgrade California Programs." Available here.

b. Insist that evaluators follow scientific principles including transparency and independence. This would help align interests and mitigate the possible incentives that evaluators – often hired by the IOUs, to assess IOU programs - might face. I have reviewed studies conducted pursuant to legislative and CPUC requirements, and I believe there is significant room for improvement on the chosen methodologies and scientific rigor.

c. Be ready to discontinue programs that are not successful.

The findings of our WAP evaluation are disappointing. I wish I could show you that the program exceeded our wildest estimates. But, I'm excited that our study has demonstrated how rigorous evaluations can tell us what works and what doesn't in energy efficiency.

It's important that California get this right. I've been involved with discussions about implementing the Clean Power Plan. Other states are planning to expand their energy efficiency programs to comply. They are looking to California. Let's provide them with a good model. The rest of the world is watching, and the planet's future depends on it.