Behavioral Assumptions in Energy Efficiency Potential Studies[1]

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June 2009

Energy efficiency potential studies express the energy savings expected from consumer adoption of energy efficient technologies under various scenarios of energy efficiency program funding. In California, Investor-Owned Utilities (IOUs) and Publicly-Owned Utilities (POUs) are required to submit energy efficiency potential studies every two years, with energy efficiency viewed as the first choice resource for future energy supply. This paper examines behavioral assumptions in energy efficiency potential studies, and proposes options for modifying and supplementing these assumptions, using recent California studies for the residential and commercial sectors as the main example. Because of the intense interest in energy efficiency as a policy solution to climate change, the examination must be approached on two levels: first, the well-bounded problem of voluntary adoption of efficient technology that energy efficiency potential studies were designed to address, and second, orienting technology adoption relative to the problem of reducing future societal energy use and greenhouse gas emissions.

As to the narrower level, California energy efficiency potential studies explicitly consider behavior as a matter of adopting energy efficient devices and building measures. Beginning with a selected portfolio of technology measures, energy savings are counted as resulting from the voluntary adoption of measures, with adoption depending on measure cost-effectiveness for the consumer subject to the effects of generalized market barriers. Utility demand-side management (DSM) programs are modeled as affecting adoption rates directly through the financial incentives that they provide to customers and by overcoming market barriers, as well as indirectly through market transformation. Behavioral change and measures that reduce levels of energy services are generally not considered in the measure portfolio. Overall, study assumptions reflect a standard theoretical model of how energy efficiency and programs promoting efficiency work in aggregate, fitting in well with a quantitative modeling exercise. Social scientists have argued that this theoretical model may rarely reflect how energy efficiency is really adopted or how it changes energy use. Their critiques do not provide much guidance as to how energy efficiency should be *modeled* differently, but do provide correctives to how policy and research problems are defined and approached, and highlight what is unknown about energy efficiency.

To operationalize their depictions of measure adoption and energy savings, energy efficiency potential studies mobilize a great deal of data and many assumptions. As well implemented as these depictions may be, the empirical and experimental data available to support assumptions is often weak. Additional experimental and observational studies could help, in particular, to better reflect the landscape of various types of decision-making (e.g., in split-incentives situations), to test how purchasers react to various incentive levels and intense marketing, and to address the variability of energy use across premises. For modeling *per se*, there are serious limits to how far model and data elaborations can go to improve quantitative estimates: forecasting social systems

[1] This paper was prepared for the California Institute for Energy and Environment and the California Public Utilities Commission. The report is available at http://ciee.ucop.edu/energyeff/behavior.html.

is innately difficult, and the classic model of how energy efficiency improvements are adopted and used may be quite flawed.

Over the past five years, two important changes in scene have occurred. First, high expectations have been set for energy efficiency's ability to produce emissions reductions toward slowing climate change. Second, new international interest in the prospects for behavioral change to support environmental goals has emerged. Device- and building component- level energy efficiency does not necessarily reduce greenhouse gas emissions, nor were energy potential studies or DSM programs originally intended to address non-purchase behavior change or absolute emissions reductions. Energy efficiency potential studies do provide, however, a constructive platform for broader thinking on reducing greenhouse gas emissions and for placing traditional DSM alongside other approaches to energy savings and emissions reductions.

To draw attention to broader possibilities, a five-layer schema is proposed. *Technical efficiency* can be defined at various levels, from individual devices to building and service provision systems. *Behavioral conservation*, meaning isolated behaviors that reduce energy services or increase the efficiency with which energy services are used, can reduce energy use, but are often not considered with the complexity they deserve. Usually set aside as pertaining to industrial, agricultural, or other energy use sectors, much energy is "consumed" *indirectly*, in the form of products or non-energy services purchased. *Lifestyle,* an ambiguous term that in the energy efficiency field generally translates to how energy service expectations are defined (e.g., domestic routines, space requirements), provides a perspective to think about how needs, desires, and practices arise and how they might be changed. Finally, *infrastructure* denotes social and technical infrastructures that create the context shaping the preceding layers. In this five-layer view, future energy use is only very partially a matter of free individual choice, thus inviting a shift in emphasis on how policy approaches future energy savings potential.

A recent Canadian study provides an example of how behavioral conservation and lifestyle change have been integrated into an energy efficiency potential study format, and points to questions about further developing this approach and limitations to such expansion. While behavior can have an enormous effect on energy consumption, the evidence and theory on creating and predicting such change, and tracing its persistence, is weak. Some alternatives to measure-based assessments of energy savings potential are suggested, for example, looking at the variability of energy consumption across time, premises, and countries.

In conclusion, the paper makes recommendations for research and for community discussion: (1) developing better quantitative and qualitative characterizations of energy-relevant purchase decisions; (2) meta-analysis of program data to support modeling and program development; (3) improved analysis of uncertainty in energy efficiency potential studies; (4) better understanding of behavioral conservation and the psychological effects of conservation communications; (5) more observational studies on what people and organizations do and think with respect to energy use, using sociological and anthropological approaches; (6) attending to the socio-technical infrastructures that shape the possibilities, needs, and desires of everyday life; (7) analysis of institutional constraints faced by researchers, funders, and policymakers, relative to the new policy problems faced, along with creating opportunities for collaborations; and (8) better communications between social scientists and the rest of the field.