Critiques of Energy Efficiency Policies and Programs: Some Truth But Also Substantial Mistakes and Bias

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Prior to ACEEE, Steve planned and evaluated energy efficiency programs for New England Electric, a major electric utility; directed energy programs for the Massachusetts Audubon Society, Massachusetts' largest environmental organization; and ran energy programs for a community organization working on housing rehabilitation in the poorest neighborhoods of New Haven, Connecticut. Steve earned a master of science in energy management from the New York Institute of Technology and a master of arts in environmental studies and a bachelor of arts in government from Wesleyan University.

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Executive Summary

Several recent studies purport to show that particular energy efficiency programs and policies do not work or are too expensive. This short paper is written for people who are not evaluation experts and are trying to understand what conclusions they can take from these studies. Here we examine many of these studies and find that while they do have some useful findings (discussed in the body of the paper), they often include a variety of unreasonable assumptions or outright mistakes that undermine their findings. We discuss six common recurring mistakes:

- Some of these studies reflect a misunderstanding of the programs and markets they are examining.
- Some of them unreasonably extrapolate their findings to areas they did not study.
- Some of the studies unreasonably distort what they in fact do.
- Many of the studies examine energy efficiency program types that are known to be less cost effective than average and not necessarily representative of all efficiency programs.
- Some studies ignore other studies that address similar programs and thus do not present the broader context that can be useful for assessing their findings.
- Some are built on a theoretical foundation that can affect and potentially bias findings.

While many of the problems alleged in these studies do not stand up to scrutiny, some problems remain. In our view, to be most useful, a study should not only look at what is happening, but also seek to understand why, and then make recommendations on ways the problems identified can be addressed.

Based on this review, we have several recommendations on ways we can constructively move forward. First, we acknowledge that not all energy efficiency programs are stellar. Sound evaluation is critical in identifying what is working well and what needs improving. Second, both the economics and energy efficiency fields must better understand where the other side is coming from and explore opportunities to find a middle ground. Third, both communities need to be fair and objective when they conduct studies. Study designs that implicitly tilt the playing field are more rhetoric than useful investigations of what is happening. Fourth, it would be useful for the economics and energy efficiency evaluation communities to work together on joint studies. Rather than each community conducting separate studies, economists and energy efficiency practitioners could work together on some studies, allowing each profession to offer its respective skills, perspectives, and information. Similarly, the two communities can work together to identify representative programs that are worth studying rather than marginal programs that address small markets or are not typical. In this way, studies can achieve what perhaps is the intended purpose: to understand what works, and to improve what falls short.

Objective evaluation is important, but unfortunately some evaluations are not as thorough as they could be. We hope this paper contributes to improvements in these studies and how the studies are used.

Introduction

Many studies have found that large and cost-effective energy and financial savings can be realized by implementing energy efficiency measures in all sectors of the US economy. For example, the American Council for an Energy-Efficient Economy (ACEEE) recently published a study estimating that 18 underutilized energy efficiency measures could reduce US electricity use by 15–31% by 2030 (York et al. 2015). Most of these measures were found to be cost effective to end users today. A similar level of cost-effective savings in the medium-term has been found by others (e.g., Granade et al. 2009). An ACEEE study (Laitner et al. 2012) estimates that by 2050, energy efficiency measures could reduce US energy use by 40-60% below forecasted levels while providing positive benefits to the US economy. Again, others have found similar results (e.g., Lovins 2011; Greenblatt and Long 2011).

On the other hand, a number of recent studies purport to show that particular energy efficiency programs and policies do not work or are too expensive. The text box on the next page summarizes a few of these efforts. This short paper is written for people who are not evaluation experts and are trying to understand what conclusions they can take from these studies. After examining many of them, we find that while they do have some useful findings, they often involve unreasonable assumptions or outright mistakes that undermine their findings.

ACEEE is a proponent of effective energy efficiency programs and policies, but we also recognize that not all programs and policies work well and that most can be improved. We are very interested in sound evaluation that helps improve programs and policies. In this spirit, after the text box on the next page we discuss some useful findings from these critical studies. We then turn to some of the common problems in these studies. We do this to alert people to these problems and to help program evaluators and researchers avoid them going forward.

After those sections, we discuss how some of the best studies are dedicated to finding out what is happening and why, and so provide valuable insights into what works and what does not. As noted above, like all types of programs and policies, energy efficiency programs and policies can always be improved, and so it is particularly useful when studies provide information that can lead to improvements.

This paper concludes with a section on suggestions for next steps. In particular, it is our hope that the economics and energy efficiency evaluation communities will work together better in the future, as each profession brings its respective skills, perspectives, and information to the effort to improve energy efficiency programs and policies.

Some Recent Studies That Question the Efficacy of Energy Efficiency Programs

M. Fowlie, M. Greenstone, and C. Wolfram. 2015 (cited here as 2015a). "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program." econresearch.uchicago.edu/sites/econresearch.uchicago.edu/files/paper_draft_06_15_clean.pdf. Worked with the Weatherization Assistance Program in several Michigan communities to offer weatherization services to about 30,000 low-income households. Ultimately about 2,000 of these customers received weatherization services. Found that weatherized homes reduced their energy consumption by an average of 10–20%. These savings were on average 39% of the savings predicted by engineering models. Average investments were about $4,580 per household, but the value of the energy savings achieved is only about half this amount.

A. Levinson. 2014. *How Much Energy Do Building Energy Codes Really Save? Evidence from California*. www.nber.org/papers/w20797 . Examines data on electricity use of homes in California of different vintages and finds no evidence that homes constructed since California instituted its building energy codes use less electricity today than homes built before the codes came into effect.

S. Houde and J. Aldy. 2014. *Belt and Suspenders and More: The Incremental Impact of Energy Efficiency Subsidies in the Presence of Existing Policy Instruments*. www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-14-34.pdf. Examines the impact of the State Energy Efficient Appliance Rebate Program implemented under the 2009 American Recovery and Reinvestment Act. Used transaction-level data on appliance sales and found that some consumers accelerated the replacement of their old appliances by a few years, but overall the impact of the program on long-term energy demand is likely to be small. Estimates the cost of energy savings at $0.61-1.46 per kWh saved, more than an order of magnitude higher than for typical utility-funded programs.

S. Batkins. 2015. "The Department of Energy: Under-the-Radar, Overly Burdensome." americanactionforum.org/research/the-department-of-energy-under-the-radar-overly-burdensome. Sums the estimated 30-year costs of new appliance standards issued by the US Department of Energy since 2007. Finds that these costs average $8.2 billion per year. Does not look at estimated benefits except to note that for two products, actual product shipments have been less than DOE estimated.

Note: The first three of these studies are by academic economists. The last study was prepared by a conservative think tank.

Some Useful Findings from Recent Studies

Evaluation is a critical component of energy efficiency efforts. Evaluation helps identify the impacts of energy efficiency programs and policies including what aspects of energy efficiency efforts are working well, which are not, and some possible paths to improving these efforts. Thus, we support sound evaluation, particularly evaluations that help identify ways to improve programs and policies since there are almost always ways we can do things better.

In this spirit, in the paragraphs below we note some useful findings from some of the recent studies discussed in the box above.

First, Fowlie, Greenstone, and Wolfram (2015a) find that in a study of the low-income weatherization program in several Michigan communities, savings were on average 39% of the savings predicted by energy audits. The audits had not been not calibrated to actual energy use. As a recent blog by Amann (2015) notes, calibrating audits to actual energy use can improve predicted savings accuracy to about 90%. For example, some households employ strategies to reduce their energy use such as closing off unused rooms or reducing temperatures at night or when nobody is home. Calibrating audits to actual use helps adjust savings estimated for these behaviors. Perhaps motivated by the Fowlie, Greenstone, and Wolfram 2015a study, the US Department of Energy (2015a) has recently solicited ideas for improving audit accuracy.

Second, Fowlie, Greenstone, and Wolfram also find that the rebound effect was small or nonexistent in the weatherized homes they studied. "Rebound" means that some weatherized households use the energy savings to increase their comfort by increasing temperature set points. Rebound has been a hotly debated issue (see Gillingham, Rapson, and Wagner 2015) and thus getting further field data on the rebound effect is useful. Fowlie, Greenstone, and Wolfram find that weatherized households set their thermostats 0.6 degrees F lower than unweatherized households, noting that perhaps these homes are less drafty and can be comfortable at a lower set point. On the other hand they find that weatherized homes were on average 0.65º F warmer although they say some measurement errors may have contributed to this change. But whether homes are 0.6º F warmer or colder, the bottom line is that the rebound effect in these homes is either nonexistent or very small. While many studies are needed to gauge rebound, this study contributes to efforts to understand it.

Third, Houde and Aldy (2014) find that net energy savings are very small when a program promotes efficient products that already have high market share. They find that incentives for ENERGY STAR® refrigerators, clothes washers, and dishwashers did not have much impact, estimating that, depending on the product, free riders were 73–92% of program participants (free riders are customers who take the rebate but would have made the same purchase decision without the rebate). Free riders were high because, as Houde and Aldy note, ENERGY STAR market share was 46–75% of product sales prior to the program. I have noted this issue previously and suggested that qualifying efficiency levels for rebates and other incentives be set at levels with only a modest market share (Nadel 1991; Nadel 2009). However this advice was not followed when DOE and states developed their appliance rebate program. When so many products qualify without incentives, the majority of participants will be free riders that contribute to program costs but not energy savings. Houde and Aldy find that the program did not save much energy, so hopefully this lesson will be better recognized in the future.[1]

Recurring Mistakes in Many of the Recent Studies

While there have been useful findings in some of these studies, there have also been a variety of mistakes that undermine or reduce the value of these studies. In the following sections we discuss six common recurring mistakes:

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[1] Later in this paper I provide an example of a more successful appliance program.

- Some of these studies reflect a misunderstanding of the programs and markets they are examining.
- Some of them unreasonably extrapolate their findings to areas they did not study.
- Some of the studies unreasonably distort what they in fact do.
- Many of the studies examine energy efficiency program types that are known to be less cost effective than average and not necessarily representative of all efficiency programs.
- Some studies ignore other studies that address similar programs and thus do not present the broader context that can be useful for assessing their findings.
- Some are built on a theoretical foundation that can affect and potentially bias findings.

For each of these areas we discuss a few examples to illustrate the issue, but we do not try to discuss every instance.

SOME OF THESE STUDIES REFLECT A MISUNDERSTANDING OF THE PROGRAMS AND MARKETS THEY ARE EXAMINING

In order to do a good job evaluating any program or policy, first it is necessary to understand the purposes of the program and policy and how it is meant to work in its intended market. With such an understanding, analyses can be conducted to see how well a program is meeting its goals and objectives. Unfortunately, some studies do not appear to have such an understanding (or in some cases, perhaps have chosen to distort the purposes of the program). A few examples follow.

Levinson (2014) sought to examine energy savings from California building codes. To do this he examined electricity consumption data. However building energy codes in the United Sates primarily address energy used for space heating and air conditioning, with some impact on water heating energy use. In California this mostly means that codes would affect natural gas and not electricity use; a study prepared for the California Energy Commission (Palmgren et al. 2010) found that 93% of California homes are heated with gas and only 5% are heated with electricity. Likewise it found that 87% of homes have gas water heating and only 7% use electricity for water heating. Thus, Levinson's analysis of electricity use missed most of the energy use that the California code is designed to save. And while codes affect air conditioning energy use, in California, with its mild climate, air conditioning energy use is modest. Nadel (2015) estimates that even if the California code worked as well as expected, home electricity use would be reduced by only about 1%, a very small change to find in a statistical analysis.[2]

As noted earlier, Fowlie, Greenstone, and Wolfram (2015a) examine the low-income weatherization assistance program in several Michigan communities. They primarily

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[2] Levinson did publish a revised study in November 2015 that added an analysis of natural gas use to his previous electric analysis. He finds that "post-1978 houses use less gas, and they do use less per degree-day when the weather is cold" (the California building code began in 1978). But he does not mention this finding in his abstract and seeks to minimize it in his conclusion, concentrating more on his electricity results.

examine impacts on energy use and more briefly look at impacts on carbon dioxide emissions. But saving energy is not the only objective of the program. As noted by Caperton, James, and Kasper (2012), "The purpose of the Weatherization Assistance Program is to increase the energy efficiency of homes owned or occupied by low-income persons, reduce their total residential expenditures such as heating and cooling bills, and improve the health and safety of families." In addition, during the period studied, another objective was job training and job creation, because the work was funded by the American Recovery and Reinvestment Act of 2009 (ARRA), "an act making supplemental appropriations for job preservation and creation."[3] Fowlie, Greenstone, and Wolfram ignored these latter objectives. In their cost calculations, they appear to have included costs to meet health and safety objectives; it is unclear whether job training costs (e.g., costs of trainees working on projects) are included in their calculations. Either they should have quantified other benefits or they should have limited the costs to only those linked to achieving energy savings, excluding costs related to health, safety, and job training.

Batkins (2015) analyzed the costs of federal appliance efficiency standards. But he ignored the purpose of the program, which is to reduce energy use. He did not examine benefits. A balanced study would understand the purpose of the program and seek to examine both costs and benefits.[4]

Many of these Studies Unreasonably Extrapolate their Findings to Areas they Did Not Study

When a study examines a particular program or market, the results apply to that program and market. Care must be taken in extrapolating these results to other programs or markets, as the results generally cannot to be applied to programs and markets that are substantially different.[5] For example, Fowlie, Greenstone, and Wolfram examined the low-income weatherization program in a set of homes in a few Michigan communities. The results may or may not apply to other Michigan homes[6] and may or may not apply to other Michigan communities.[7] The results probably do not apply to weatherization in other states, since there are substantial differences in how each state implements its program as well as differences in climate and energy efficiency measures used. And the results certainly do not apply to other energy efficiency programs and measures more broadly. Unfortunately, the policy brief accompanying the study (Fowlie, Greestone, and Wolfram 2015b) overstates the findings, saying that "residential energy efficiency appears to be a poor investment on average" This statement attempts to apply the results to all weatherization, regardless of location and home type, as well as to other residential programs such as those intended to

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[3] This is the beginning of the long title of the bill. See en.wikipedia.org/wiki/American_Recovery_and_Reinvestment_Act_of_2009.

[4] As discussed later, the reverse is also true. Studies should not just examine benefits and ignore costs.

[5] This same comment also should apply to use of deemed savings estimates.

[6] As discussed later in this paper, Hogan (2015) found that the homes in the Fowlie, Greenstone, and Wolfram 2015a study used less energy pre-weatherization than the typical program participant.

[7] Weatherization program implementing agencies differ in approach and quality of work.

reduce energy use of lighting or appliances, despite the fact that these other programs were not studied.

The Houde and Aldy (2014) study has the same problem. The authors examine a DOE appliance rebate program established under ARRA, finding the program did not save much energy, as least for the appliances they examined. As discussed above in the section Useful Findings from Recent Studies, we concur with this finding. But they then extrapolate this finding to other appliances that they did not examine, and furthermore state that "our findings add to the growing body of evidence suggesting that energy efficiency subsidies tend to have a high cost to society due to various unintended consequences." To support this statement they refer to a few other studies on appliance programs and one vehicle program. All of their examples are for programs with a high number of free riders (participants who contribute to program costs but not program benefits), a problem that can and should have been identified in the program development process and the program designs modified to reduce free riders (Nadel 1991). And none of their examples extend to programs outside of the household sector.

One final example of this problem is the Batkins (2015) study on the DOE appliance standards program. As noted earlier the author looks primarily at program costs and not benefits. The only statement he makes about benefits is to find two examples of products for which shipments declined since 2005, and he uses these two examples to question the amount of energy savings DOE estimated. However these are only two products (residential central air conditioners and microwave ovens) out of 10–26 products he examines (10 in one table, 26 in another). He says these two data points "call into question the assumptions of [DOE]" but provides no data on other products. We note that the Great Recession affected both new construction and replacement sales of air conditioners during this period, and sales have partially rebounded since.[8] And in the case of microwaves, Ferdman (2014) discusses the slow death of the microwave market since 2004, a trend he attributes to high product saturation (most households now have one) and declining use of microwaves. Also, if sales are less than DOE estimated, costs will also be less than DOE estimated, and thus lower sales will only have a modest impact on the *ratio* of costs to benefits.

SOME STUDIES UNREASONABLY DISTORT WHAT THEY IN FACT DO

Some of these studies appear to unreasonably distort what they do. The clearest example of this is Batkins (2015), who only examines the costs of the program, ignoring the benefits. Estimates of the benefits are available from a variety of sources including DOE (undated) and the American Council for an Energy-Efficient Economy/Appliance Standards Awareness Project (Lowenberger et al. 2012). More recently, a major evaluation was published by researchers from Lawrence Berkeley National Laboratory and Stanford University (Taylor, Spurlock, and Yang 2015). Batkins also appears to cherry pick data to help make his case, as discussed in the section above.

[8] Shipments were up 33% in 2014 relative to the 2009 shipments used by Batkins. See www.ahrinet.org/site/496/Resources/Statistics/Historical-Data/Central-Air-Conditioners-and-Air-Source-Heat-Pumps.

Another example is the Fowlie, Greenstone, and Wolfram study (2015a) we have previously discussed. In their various materials they discuss how they "administered a randomized controlled trial (RCT)—considered the gold standard in evidence—on a sample of more than 30,000 WAP-eligible households in the state of Michigan."[9] However a review of the details of their study shows that many of these (more than 20,000) were a control group, 7,549 were encouraged to get weatherization, and 2074 homes were weatherized.[10] Ultimately they were able to obtain data on 436 of their experimental homes, which was too small a sample to get useful statistics from their RCT experiment. To improve the statistics they included an additional 1,473 weatherized homes that were not part of their RCT sample.[11] Ultimately, their energy savings results come not from an RCT, but from the quasi-experimental approach that is extensively used in energy efficiency evaluation.[12]

A Note on Randomized Control Trials (RCT)

RCT can be a powerful technique, since the experimental and control groups come from the same population; therefore the two groups are identical except for their participation in the program. But randomized control trials can be very difficult to implement, as Angus Deaton, the recent recipient of the Nobel Prize in Economics has discussed (Ogden 2015). Specifically, Deaton notes "like any other method of estimation, it has its advantages and disadvantages." Among the issues he notes are the assumptions that need to be made, "at least if you're going to use them for anything," "how you take the result from one experiment and how it would apply somewhere else," and small sample sizes that can lead to "enormous standard errors" (the statistical plus or minus around an average). The Fowlie, Greenstone, and Wolfram (2015a) study illustrate some of these problems: they ultimately got too small a sample to statistically analyze the energy savings from their RCT sample. Also, as noted by Ohio Partners for Affordable Energy (2015) and Hogan (2015), in recruiting potential participants from their sample, Fowlie, Greenstone, and Wolfram used different procedures and methods than the weatherization program normally uses, resulting in a sample of weatherization participants who used less energy prior to weatherization than the average weatherization program participant.

Many of These Studies Examine Energy Efficiency Program Types That Are Known to Be Less Cost Effective Than Average

Many of the studies that have questioned the cost effectiveness of energy efficiency have looked at the more expensive programs per unit of energy saved. A recent review by Lawrence Berkeley National Laboratory of utility-funded energy efficiency programs (Hoffman et al. 2015) found that low-income programs were the most expensive program type examined followed by residential new construction and whole-home retrofits (see table 1 below). These are the program types examined by Fowlie, Greenstone, and Wolfram 2015a (low-income weatherization), Levinson 2014 and 2015 (residential new construction), and

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[9] See epic.uchicago.edu/news-events/news/do-residential-energy-efficiency-investments-deliver.

[10] See table 2 in Fowlie, Greenstone, and Wolfram 2015a.

[11] See table 3 in the appendix to Fowlie, Greenstone, and Wolfram 2015a.

[12] While many energy efficiency programs have been evaluated with quasi-experimental approaches, probably the majority have been evaluated with less rigorous approaches. We discuss this point near the end of this paper.

Fowlie, Greenstone, and Wolfram 2015b (a forthcoming study on whole-home retrofits).[13] Only one of the recent economic studies (Houde and Aldy 2014) looked at a lower-cost program category—consumer product rebates—although as discussed above, they selected a particularly poor example of such a program. None of the recent economic studies have looked at the commercial/industrial sectors, although one forthcoming study is looking at schools (the most expensive of the commercial/industrial categories).[14]

Table 1. Total cost of saved energy by sector and program type

Sector and program type	Average cost (cents per kWh saved)
Low-income	14.2
Other residential	3.3
New construction	11.1
Whole-home retrofit	9.4
Multifamily	7.1
Behavior/normative feedback	5.7
Prescriptive	5.4
Consumer product rebates	2.1
Commercial and industrial	5.5
MUSH* and government	8.5
Small commercial	6.3
Custom	5.2
Prescriptive	4.5
New construction	4.2
All sectors	4.6

This table summarizes the results of hundreds of programs; an array of approaches was used to evaluate these different programs. * MUSH is municipalities, universities, schools, and hospitals. *Source:* Hoffman et al. 2015.

Furthermore, in the case of the Fowlie, Greenstone, and Wolfram 2015a study, as shown by Hogan (2015), the households included in the Fowlie, Greenstone, and Wolfram study used

[13] See e2e.haas.berkeley.edu/current-projects-homeenergy.html.

[14] e2e.haas.berkeley.edu/current-projects-schools.html.

less energy per year than the average home that participates in the low-income weatherization program, making the Michigan program studied less cost effective than the average low-income weatherization program. (If base energy use is less than average, then absolute energy savings will also tend to be less than average.)

Some Studies Ignore Other Studies that Address Similar programs and Thus Do Not Present the Broader Context that Can Be Useful for Assessing Their Findings

Generally, good practice in evaluation research is to reference other studies that look at similar programs and to discuss how the findings in your study compare to findings in these other studies. Unfortunately, with the partial exception of the Houde and Aldy study, none of the studies summarized in the box on page 2 of this paper compare their results with those of other studies.

For example, Levinson discusses the methodologies some other studies use but does not attempt to compare his results to those of some other studies. Other studies that would be useful for comparison include Aroonruengsawat, Auffhammer, and Sanstad (2012), who found per capita energy use reductions of 3–5% in states with building energy codes after controlling for other factors; Deason and Hobbs (2011), who found that homes built under energy codes used about 10% less energy than those not built under codes; and Jacobsen and Kotchen (2013) who found 4–6% energy savings from an update to Florida's building energy code.

Likewise, Batkins ignores studies on the benefits of appliance efficiency standards, such as DOE (undated), which estimates $227 per year of annual household energy bill reductions attributable to appliance standards, with total energy bill savings of over $950 billion through 2020, growing to over $1.7 trillion through 2030. Other useful studies on benefits are by Lowenberg et al. (2012) (net benefits of about $1 trillion after subtracting costs) and Taylor, Spurlock, and Yang (2015). This latter study was an ex-post evaluation and found that (1) rulemaking analyses significantly overestimated observed product prices, (2) the energy efficiency of products purchased after regulation generally exceeded the regulated standards, (3) unregulated aspects of product quality at the time of sale often improved in conjunction with standards events according to available models reported on in third-party testing, and (4) product reliability generally improved over the period of time the products have been regulated.

Similarly, Fowlie, Greenstone, and Wolfram do not discuss the many dozens of previous weatherization program evaluations as summarized by Schweitzer (2005). And since Fowlie, Greenstone, and Wolfram released their paper, a comprehensive national evaluation by Oak Ridge National Laboratory found that the weatherization assistance program produced present value benefits (energy, health, and safety) of more than $13,000 per home at a total cost per home of $4,695–$6,812 (DOE 2015b).[15]

[15] Greenstone and Wolfram (2015) examine the DOE estimates in a subsequent blog post. They question several of the Oak Ridge estimates of the value of several benefits and suggest that more rigorous analysis is needed to better estimate these benefits. Reading this blog post, I conclude that there are substantial benefits beyond direct energy savings, but that Oak Ridge may have overestimated the total amount of benefits.

Turning to Houde and Aldy, they do compare their results to another study of the same program by a DOE contractor. The results are very different, but Houde and Aldy track the differences to free riders; the other study appears to include benefits from free riders while Houde and Aldy do not. However Houde and Aldy do not examine other products covered by the same DOE program that are likely to be more cost effective (Nadel 2014) nor do they examine other appliance programs with lower free rider levels (for example, note the relatively low cost of consumer product rebates in table 1). To provide just one example of a much better program, the Northwest Energy Efficiency Alliance offered programs to spur development, stocking, and sales of improved efficiency clothes washers, providing funding over the 1997–2007 period. At the beginning of the program, 2% of clothes washer sales in their region met the program's efficiency requirements; by 2001 the market share increased to more than 20% and qualification levels were raised. By 2011 the qualification levels had been raised several times and all clothes washer sales qualified as these performance levels were now the basis for revised DOE minimum efficiency standards (NEEA undated).

SOME STUDIES ARE BUILT ON A THEORETICAL FOUNDATION THAT CAN AFFECT AND POTENTIALLY BIAS THEIR FINDINGS

Some studies are built on a belief that markets are near perfect, consumers make rational decisions, and anything that disturbs markets must raise costs. This point is illustrated by the Batkins (2015) paper discussed previously that looks only at the costs of regulations and ignores the benefits. This point is elaborated on in a paper by Gayer and Viscusi (2012) that argues that consumers may be rational when they purchase inefficient vehicles or appliances because there may be nonenergy costs that offset the benefits. They note, for example, that consumers like such features as vehicle acceleration, vehicle cargo capacity, and clothes washers that can load from the top, and they suggest that these attributes have value that may offset the energy cost savings of more efficient vehicles and appliances. Gayer and Viscusi also note that other studies have found implicit consumer discount rates of 20% or more (they are implicit in that for some actual consumer decisions, a discount rate of 20% of more would be needed for a decision to purchase a less efficient product to be economically rational).[16]

We agree that nonenergy costs such as vehicle acceleration, cargo capacity, and how a clothes washer is loaded should be considered. But these are limited examples and do not address the fact that there are also large differences in energy efficiency among vehicles and appliances with similar attributes. For example, the most fuel-efficient large SUV on the market in 2016 used 55% fewer gallons of fuel per mile driven than the least efficient large

[16] A discount rate is applied in economic analysis to address the time value of money. A dollar saved or spent today is more valuable than a dollar spent or saved in the future, because in the intervening time that dollar could have been put to use. The US Office of Management and Budget directs agencies to use discount rates of 3% and 7% per year when examining prospective regulations. These rates are real rates, meaning that they are in constant dollars (e.g., 2015 dollars) and do not include the effects of inflation. If inflation were included the rates would be higher.

SUV.[17] Likewise, the most efficient top-loading clothes washer on the market uses less than one-fifth of the energy of the least efficient.[18]

Applying a simple 20% discount rate to all decisions can have a very large impact on the results. For example, Krupnick et al. (2010) find that building, lighting, and appliance standards have a cost of $60 per ton of carbon reduced when calculated using a 20% discount rate, but this declines to $7 per ton with a 5% discount rate.

It is also important to point out that the choice of discount rate should not be based on just purchaser decision making. For example, many utilities operate energy efficiency programs because energy efficiency is less expensive than building a power plant. In this case the appropriate discount rate is probably the cost of capital for building a power plant (currently about 5% real)[19]. Use of a 20% discount rate would severely distort the analysis, resulting in very little efficiency investment and hence the need to build more power plants, raising electric rates for all customers.

Features of Good Studies

So far in this paper we have mostly looked at studies that allege to find problems with energy efficiency programs and policies. While upon closer examination many of these alleged problems do not stand up to scrutiny, some problems still remain. In our view, to be most useful, a study should not only look at what is happening, but also seek to understand why, and then make recommendations on ways the problems identified can be addressed.

A good example of looking beyond the superficial findings is a paper by Withers and Vieira (2015). Withers and Vieira compared the energy use of a sample of homes built to the 2009 Florida code with the energy use of a sample of homes built to the code in effect during 1984–1985. Previous building energy simulations by their colleagues had compared the 1984 and 2009 energy codes and predicted energy savings of about 50% for combined heating, hot water, and cooling energy use. But when Withers and Vieira compared actual energy consumption of 1984 and 2009 homes for these end uses, they found only a 7–13% difference (varying depending on what specific data they used). Given such data, less rigorous researchers might have concluded that the Florida building code was not working well. Fortunately, Withers and Vieira were very scrupulous and realized that to fully evaluate this code, they had to look at more than energy consumption data. They decided to dig deeper, collecting and comparing detailed data on the homes. They found a number of factors that helped explain the lower-than-expected energy savings:

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[17] Based on average of city and highway ratings as reported by www.greenercars.org. The best SUV was the Chevrolet Colorado/GMC Canyon (average rating of 26.5 mpg (miles per gallon). The worst was a Mercedes Benz (12 mpg). Gallons per mile is calculated by 1 MPG.

[18] Based on annual kWh as reported at ahamverifide.org/search-for-products/clothes-washers.

[19] Utility cost of capital averaged 5.58% nominal as of January, 2015 according to pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm . If we factor out inflation (as measured by the GDP deflator), running at about 0.9% per year (research.stlouisfed.org/fred2/series/GDPDEF), then the cost of capital in real terms is about 4.8% (1.0588/1.009).

- In the old homes, much of the equipment (furnaces, air conditioners, water heaters, and appliances) had been replaced, and the new equipment was much more efficient than the requirements in the 1984 code. The authors attribute the changes to appliance efficiency standards, energy efficiency programs, education efforts, and higher energy prices.
- The older homes had more attic insulation on average than was required by the 1984 code.
- Temperatures in the older homes averaged about 1°F higher during the summer and about 0.6°F colder during the winter. In other words, some of the new code's benefits were being taken in the form of slightly increased comfort.
- A somewhat warmer-than-normal winter affected the data on actual energy use.
- The newer homes had more miscellaneous energy loads (gadgets).

Interestingly, code compliance was not a significant factor. The authors found a 90% compliance rate and estimated that the out-of-compliance items resulted in an annual impact on energy use of 1% or less.

Withers and Vieira then ran the energy use simulations again to compare the homes adjusting for these factors. The first factor (subsequent upgrades to appliances and equipment) was the most important, but, accounting for all the factors, the revised simulated energy use of the new homes was 9% lower than the older homes, near the midpoint of the 7–13% difference they found in actual energy consumption data.

The authors conclude that "[the code] has made a significant difference, but measured savings compared to older homes 25 years after construction are decreased by years of home improvement efforts."

Another example of trying to understand why savings might be less than expected can be found in Houde and Aldy (2014), who identified high free rider levels as a significant problem in the appliance rebate program they evaluated. It would have been useful if they recommended that future programs set eligibility levels significantly higher in the future so that free rider levels would be much lower. Likewise, Fowlie, Greenstone, and Wolfram (2015a) identified a problem with inaccurate audit predictions. It would have been useful if they went a step farther and identified ways to address this problem, such as calibrating results to actual baseline use, as Amann (2015) recommends. A final example is work by Hogan (2015) to understand reasons why Fowlie, Greenstone, and Wolfram (2015a) and Tonn et al. (2014 and 2015) reached very different conclusions about the weatherization assistance program. She found that both studies found similar levels of savings on a percentage basis, but the Fowlie, Greenstone, and Wolfram homes used less energy prior to weatherization. Also, valuing the nonenergy benefits of weatherization was a major difference between the two studies. As discussed previously, Greensotne and Wolfram (2015) questioned some of the estimates made by Tonn et al., indicating an area where further work is needed.

Suggestions for Moving Forward

Based on this review, some recommendations emerge on ways we can constructively move forward. First, we acknowledge that not all energy efficiency programs are stellar. Sound evaluation is critical in identifying what is working well and what needs improving.

Second, there is a need for both the economics and energy efficiency fields to better understand where the other side is coming from and to explore opportunities to find a middle ground. Both communities have a tendency to work from established paradigms and with colleagues who share similar views. When the two communities meet they often talk past each other. For example, many economists look for rigorous evaluation, preferring what they call the gold standard—randomized control trials. But as discussed above, randomized control trials can be very difficult to implement. This is particularly a problem for full-scale programs in which everyone is eligible and random assignment to a control group is not possible. On the other hand, the energy efficiency community in recent years has increased use of deemed savings estimates, since these are easier to use and provide certainty for program implementers. Deemed savings estimates are supposed to be based on prior evaluations, but these evaluations are not always as rigorous or frequent as they should be.[20] Perhaps the two sides could agree on more frequent quasi-experimental studies that carefully select a control group that is not randomized. And when pilot studies are conducted, randomized control trials should be considered.

Both communities need to be fair and objective when they conduct studies. Study designs that implicitly tilt the playing field are more rhetoric than useful investigations of what is happening. Examples of tilting the field include studies that look at only costs but not benefits (e.g., Batkins 2015), include extra costs unrelated to energy efficiency (e.g., home repair costs, as shown in Fowlie, Greenstone, and Wolfram 2015a), leave out important costs such as changes in the value of products to consumers (a problem with some energy efficiency evaluations, as discussed by Gayer and Viscusci 2012), or are based on a simple cost–benefit framework without considering other goals that the programs might have (again, Fowlie, Greenstone, and Wolfram 2015a). Likewise, each program is different, and one problematic program should not call into question all the others, particularly dissimilar programs. Conclusions can only be generalized to similar programs.

It would be useful for the economics and energy efficiency evaluation communities to work together. Rather than each community conducting separate studies, economists and energy efficiency practitioners could work together on some joint studies, as each profession offers respective skills, perspectives, and information. Economists tend to be good at research methods and statistics, but they do not always understand the markets they evaluate. By coupling economists with knowledgeable practitioners, many of these problems can be avoided. Likewise, it would be useful to have the other community review studies before they are released so that problems can be identified and corrected before publication. Unfortunately, some of the recent economics papers have sought publicity on working

[20] We hope to explore this topic more fully in a future paper.

papers that have not yet gone through peer review or review by energy efficiency program and evaluation experts.[21]

Similarly, the two communities can work together to identify representative programs that are worth studying, rather than marginal programs that address small markets or are not typical. For example, large savings come from lighting programs (both residential and business) and from commercial and industrial custom measure programs; additional evaluation of these program types could be useful. Finally, when results are obtained, it can be useful to look at what caused them (as Withers and Vieira [2015] do). In this way, studies can achieve what perhaps we can all agree is the intended purpose: to understand what works, and to improve what falls short.

Finally, since this paper was written for people who are not evaluation experts or academic economists, we hope this discussion will help them better understand the issues involved, what conclusions they can take from these recent studies, and also how to read and consider future studies. Objective evaluation can be useful, but unfortunately, some evaluations are not as thorough as they could be. We hope this paper contributes to improvements in these studies and how the studies are used.

[21] See e2e.haas.berkeley.edu/featured-eeinvestments.html and freakonomics.com/2015/02/05/how-efficient-is-energy-efficiency-a-new-freakonomics-radio-podcast.

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